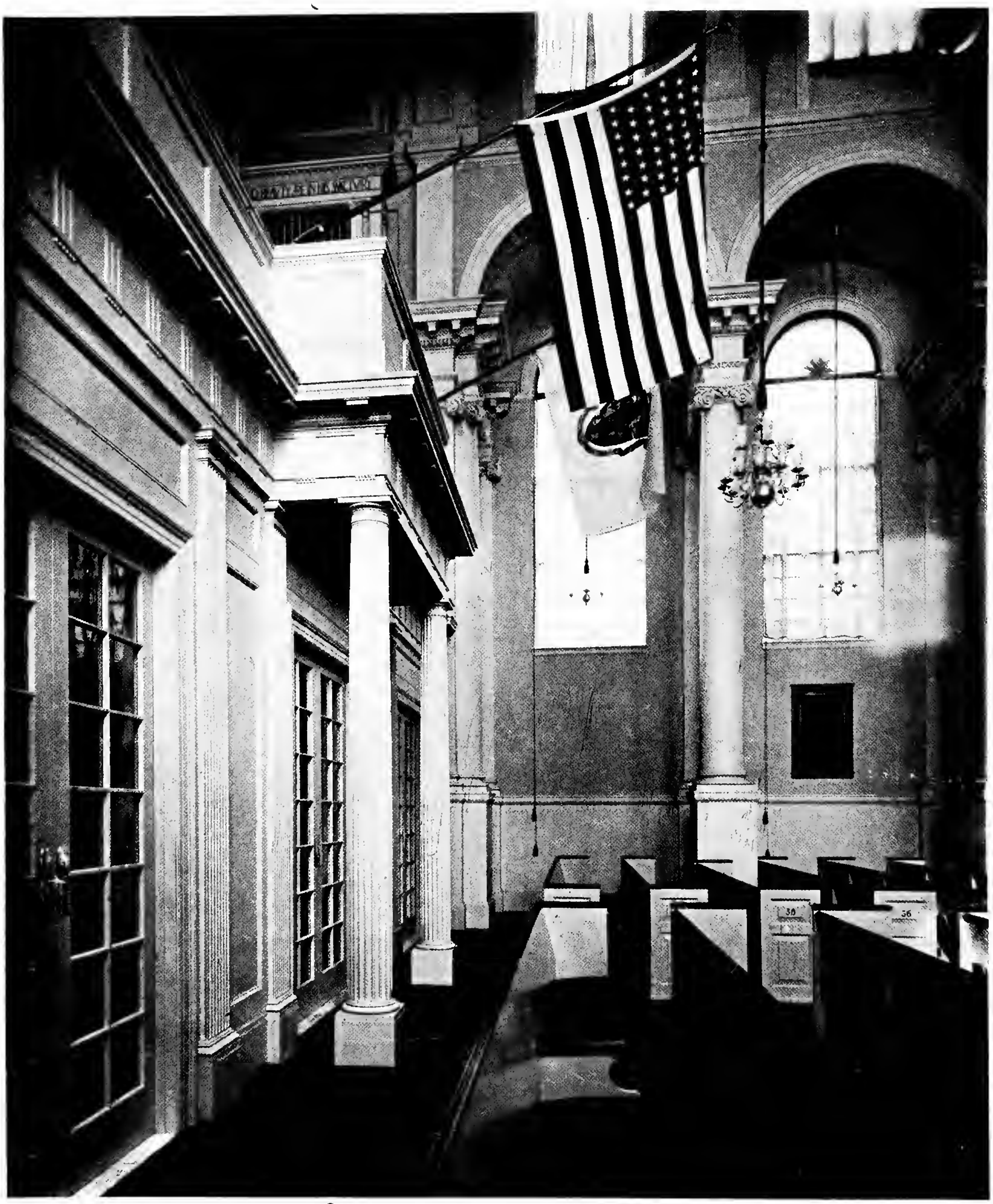


THE SECOND CHURCH IN BOSTON, UNITARIAN

MESSRS. CRAM & FERGUSON, *ARCHITECTS*

AMERICAN CHURCHES

VOLUME I

A Series of Authoritative Articles on Designing, Planning, Heating, Ventilating, Lighting and General Equipment of Churches as Demonstrated by the Best Practice in the United States

WITH AN INTRODUCTION BY

RALPH ADAMS CRAM, LITT.D., F.A.I.A., F.R.G.S.

SENIOR PROFESSOR OF ARCHITECTURE, MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HONORARY CORRESPONDING MEMBER, ROYAL INSTITUTE OF BRITISH ARCHITECTS

To Which Is Added More Than 200 Full Page and Text Illustrations of Recently Constructed American Churches

NEW YORK
THE AMERICAN ARCHITECT
1915

Among Architects Whose Work in Church Design is Illustrated in this Volume are the Following

Henry Vaughan

Charles C. Haight

Cram, Goodhue & Ferguson
(Boston Office)

Allen & Collens

Cram & Ferguson, Boston

Edward Pearce Casey

John William Donohue

Eckel & Boschen

Elmer Grey

William C. Hays

Howells & Stokes

Myron Hunt

Edgar A. Matthews

Maginnis, Walsh & Sullivan

Nelson & Van Wagenen

Julius A. Schweinfurth

A. Durant Sneden

James E. Ware & Son

Watson & Huckel

Among Contributors to Text in this Volume are the Following

Ralph Adams Cram, Litt.D., F.A.I.A., F.R.G.S.,
Senior Professor of Architecture, Massachusetts Institute of Technology. Honorary Corresponding Member Royal Institute of British Architects

William H. Goodyear, M.A.
Curator of the Department of Fine Arts, Brooklyn Institute Museum
Corresponding Member American Institute of Architects, etc., etc.

The Rev. Robert Ellis Jones, S.T.D.
Canon, Cathedral of St. John the Divine, New York

Professor Wallace C. Sabine,
Harvard University

D. D. Kimball,
President American Society Heating and Ventilating Engineers.
Member New York State Committee on Ventilation

F. A. Pattison, A.S.M.E., A.I.E.E.
Illuminating Engineer

THE SECOND CHURCH IN BOSTON, UNITARIAN

MESSRS. CRAM & FERGUSON, *ARCHITECTS*

PREFACE

IF, in the year 1885 or thereabouts, one had ventured to predict that in twenty-five years the architectural magazines would be printing special issues devoted wholly to contemporary ecclesiastical architecture, he would have been considered a fit subject *de lunatico inquirendo.* At that time the parlous state of architecture was nowhere more acutely manifest than in church building: the Colonial and Jeffersonian traditions were both gone and it was the fashion then to embellish the interiors of the examples of the latter mode with "æsthetic" stenciling in tertiary colours and sunflower patterns, and to paint those of the former, three shades of olive green without, while filling their windows with preposterous stained glass. The fine Upjohn impulse was still operative through such sincere and able practitioners as Renwick, Haight and Congdon, but it had just received its death blow at the hands of Richardson who, in Trinity and the "Brattle Square" churches in Boston had promulgated a new style as vigorous and compelling as it was alien and evanescent.

Generally speaking, the Episcopal Church still adhered to the Victorian Gothic propaganda, though her sudden advance in numbers, wealth and power had only just begun and her activities were therefore not widespread. The Protestant denominations also were hardly more than holding their own, but whatever they did was pretty generally along the inadequate lines of Richardson's immediate successors, while the Roman Church, hardly as yet touched by the flood of immigration that was to raise her numerically to the first place, was just at the start of her career of building multitudes of the very worst religious structures ever conceived by man.

In the same year, 1885, evolutionary philosophy and the "religion of science" were at their climax: everywhere one heard reports that historic Christianity and dogmatic religion were doomed and that they could hardly last out the century. Altogether the future of ecclesiastical architecture seemed black indeed, here in America, and this dubious prospect was only intensified as soon as men began coming back from Paris where the Ecole des Beaux Arts knew nothing of it save as an archæological exercise, and the new architectural foundations at various technical schools and colleges followed suit.

It was impossible to study church building or acquire any knowledge of the principles of religious expression through art, in any of the schools, and in few of the architects' offices. In England, alone, was there any vitality in the art, but there, thanks to the Catholic revival, it was intense: Scott, Pierson, Bodley, Garner, with scores of others, and with Bentley, Sedding, Paley, Stokes, Wilson soon to follow, gave a new life to the art, and for a generation it followed a course of vigorous development that almost rivalled the unique record of the English Middle Ages. The question was: would it come over-seas? had it as a foundation a spiritual vitality in the Church itself that would perpetuate it there and, crossing the ocean, do battle with the dominant secularism, the stolid Protestantism, the crescent agnosticism and, victorious, bring into being a new era and a regenerated art?

There does not seem to be much question as to the answer. Twenty-five years have seen a sea-change that staggers the understanding. In the same period America has developed a domestic architecture that, whatever its forms of expression (and they are legion) is striking in its beauty and distinction: a commercial architecture that is logical and distinguished, a public architecture of splendid culture, refinement and nobility, but not one of these really quite equals what has been done in church building. Wherever you go, whatever "household of faith" you consider, you find an astonishingly high level of excellence, while the ever increasing number of new churches casts an humourous light on the smug predictions of an imminent end of formal Christianity.

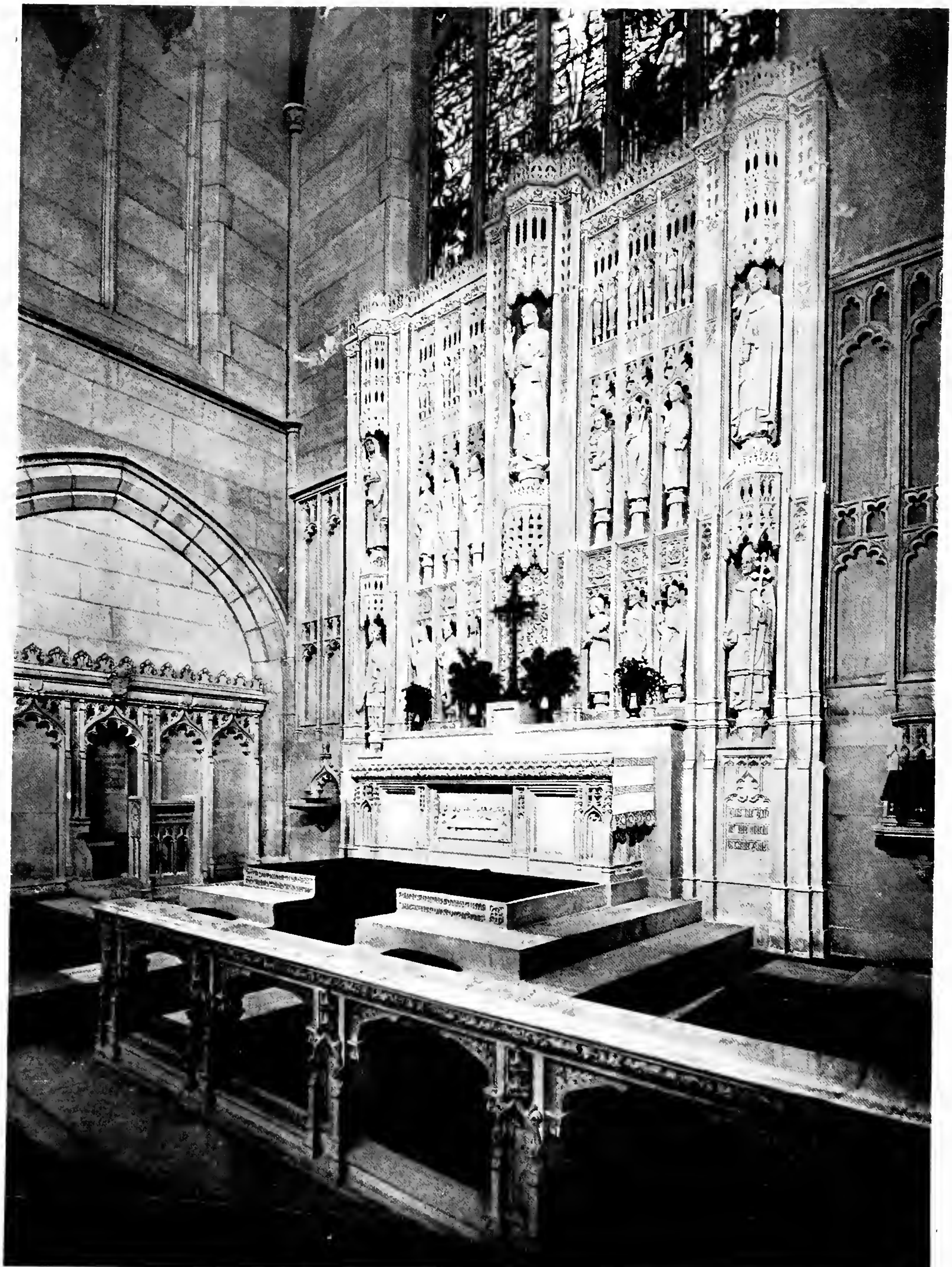
Naturally enough, the Episcopal Church has taken the lead, for dogmatically, spiritually and historically she was bound to the tradition of noble art: close on her heels follows now Presbyterianism, demanding and getting an art as rich and Catholic as that of Anglicanism: now at last Rome follows suit and here and there is actually breaking away from the appalling precedent of the last decade of the last century. Amongst the other denominations there are not a few sporadic cases of a recovery of true art, but Congregationalism, whether Trinitarian or Unitarian, is not very active today and so builds comparatively little, while Methodists and Baptists are as a whole content with the lower standards of a past generation. The Swedenborgians almost invariably build well, in spite of their small numbers; the Christian Scientists almost invariably ill in spite of their wealth: on the whole, however, one can say that the major part of the output, particularly in the North from Maine to Minnesota, and on the Pacific coast as well, is of a degree of excellence, significance and distinction that is inexplicable except on the assumption that formal, dogmatic Christianity has taken on a new lease of life that is so spiritually efficient and so crescent in its nature that it has forced for itself a new natural expression that almost equals that of the great Middle Ages.

Stylistically there appear to be three parallel lines of development, English Gothic, Lombard and Colonial: all are being treated with great suppleness, individuality and adaptability, without archæological affectation, but also without that crass individualism that destroys style and hampers expression. The first is followed almost exclusively both by the Episcopal Church and the Presbyterians, the second by the Roman Church, the third by Congregationalists. Notable instances occur frequently of Roman Catholic Gothic and Presbyterian Lombard, but Colonial meeting houses, other than Congregational or Unitarian, are rare, while modern classic seems practically confined to the Christian Scientists, with occasional cases in the Roman Church.

The recovery of sound Colonial principles during the last decade is very notable: when first it came again into fashion it was shockingly mishandled, but it has been subjected to the most careful and devoted study; almost every existing example has been noted, measured and recorded, and now it is being treated with a refinement and penetration that have most notable results. A generation ago, Gothic was already established on sound lines in America, while in England it had actually been re-created and made as living and organic as in the Middle Ages. Since then the development, which is no less than marvelous, has been in degree rather than in kind, and as the fire seems to be dying away in the English "Establishment" it is being taken over by the Roman Church in Great Britain and the Episcopalians and Presbyterians in America. Lombard is an entirely new affair. In England it appeared closely associated with Byzantine, though naturally enough it never achieved any popularity as it was recognized as alien to British blood, temper and tradition. In America the case is different since the nation is no longer even predominantly Anglo-Saxon, and handled as it has been, with striking perception and delicacy, it has already produced many works of rather unusual beauty.

Whoever is working, and whatever the style, we find now a degree of appreciation of fundamentals, a distrust of mere ornamental details as sufficient in themselves, a devotion to honest construction, a general grasp of the problem as an organic whole, that argue well for an immediate future of distinguished accomplishment. The schools still very largely disregard the whole subject, but the remarkable work of the last twenty-five years has been produced without their aid and in the meantime a great number of able young men have been trained in the offices of the producing architects, so there need be no fear that the work so well begun will languish, or that there will be any falling off in the next generation from the high standards established by the last.

Ralph Adams Cram.



REREDOS, ST. MARKS CHURCH, FRANKFORD, PHILADELPHIA, PA.
MESSRS. WATSON & HUCKEL, *ARCHITECTS*

Modern Church Architecture and Medieval Refinements

By WILLIAM H. GOODYEAR, M.A.

Hon. Member Society of Architects, Rome; Hon. Member of Edinburgh Architectural Association; Hon. Member Royal Academy of Fine Arts, Milan; Hon. Member Royal Academy of Venice; Corresponding Member American Institute of Architects.

THE elementary conditions of the ordinary mason's art naturally involve the use of rectangular forms and, consequently, of strictly rectilinear and strictly perpendicular construction. According to the orthodox modern practice and according to the orthodox modern theory of what ought to have been good practice in other periods, any departure from the rectangle, the straight line, or the true perpendicular, in building, is, therefore, presumably due to accident, to carelessness, to inefficiency, or to natural and inevitable human fallibility where minute measurements are concerned. From the same point of view equal dimensions, equidistant measurements and corresponding measurements, for corresponding and repeated features of any individual part of any individual building, are presumed to be the normal rule. In fact any other practice would create very serious difficulties for the draughtsmen of a modern architect's office, as they are trained at present.

Wherever the profession of building is distinct from the profession of architecture, and wherever the former profession simply carries out what the latter profession has drawn out for it on paper, the sciences of geometry and of mathematics, as applied to architecture, appear to be entrenched in a fortress from which it is very difficult to expel them. The paradox of the theory of architectural refinements is that nothing should be exactly where it is presumed to be and that the cultivated eye is charmed by the mystification resulting from unforeseen and unrealized displacements which set at defiance those formulas of geometry and mathematics which are, notwithstanding, apparently followed and employed. This paradox appears to be so close to nonsense or to involve such great difficulties for the modern architect, if it is not nonsense, that the best preface to our subject is a series of quotations from several of the most renowned authorities on the architecture of the Middle Ages.

In Viollet-le-Duc's Dictionary, we find, under the title of "Trait" the following passage apropos of certain distortions and asymmetric arrangements in the plan of the Cathedral of St. Denis:

> "These refinements (délicatesses) appear strange to us nowadays, and instead of searching out their meaning or verifying their effects we prefer to attribute these 'defects of planning' to the ignorance of these ancient artists, in spite of the fact that we are ready to marvel the next day, at no less important irregularities as noticed in the monuments of Greek Antiquity, irregularities which are the result of optical considerations *(besoin de l'œil)* and of a very delicate appreciation of perspective effect. . . . Such a method required, it is true, a very complete knowledge of geometry, not only on the part of the master mason, but also on the part of the workmen . . . but it will probably not be suggested that a knowledge which was pushed so far by the master, and which was so easily understood by his assistants, has ever been an indication of ignorance or of barbarism."

The above quotation gains additional significance when we add to it another from the pen of Auguste Choisy who is known to have contributed much material, in his earlier years, to Viollet-le-Duc's Dictionary. The passage which follows here is connected with a description of certain arrangements, designed for perspective illusion which are mentioned as occurring in specified churches:

"These irregularities are visibly intentional. There are others which must be charged to the account of builders' errors, but if we consider the original and almost subtle spirit of the Gothic architects we shall be persuaded that there was design more frequently than negligence."* . . . . . . "*Asymmetries*—Architects who analyzed with this refinement the play of perspective† must have had a poor opinion of those symmetric arrangements which are upset by perspective and which the play of light and shade is always complicating. The law of symmetry, as we now understand it, and which consists in reproducing on the left side the arrangements made on the right—this rather narrow rule—plays a very secondary rôle in the Middle Ages. On this head, as on so many others, the point of view of the Gothic builders was that of the Greeks. Asymmetry appears acceptable as soon as an evident reason justifies it. If an edifice is placed in an enclosure, the plan follows that of the enclosure. Two spires are erected successively, architecture has progressed meantime and all its improvements are accepted in the new construction, in spite of the resulting contrast. Generally speaking the architects of the Middle Ages avoid formal regularity. If they admit a symmetrical effect in the total result, they know how to avoid monotony by details which are infinitely diversified. Notre-Dame has on its façade three portals erected at one time; from left to right only the effects of mass are balanced, while each one has a character of its own. These differences give a charming variety to the composition; a feeling of sympathy attaches us to these works in which the designer has disdained the effect of a set pattern, in

FIG. 1.

The Temple Church, London, looking toward the choir. This view shows the widening refinement, by six plumb lines. All the piers lean out uniformly, to the same amount, with inclinations in straight lines which start from the tops of the pedestals. These are perpendicular. The inclinations are 4 inches to a side, in a height of 15 feet to the capitals, including the perpendicular pedestals. On the extreme right and left of the picture are seen portions of the pilasters which flank the opening into the adjacent circular church, of earlier period. These are perpendicular.

Photographed by the writer, for the Brooklyn Museum, in 1914.

*Several paragraphs about the mediæval use of the entasis in spires and the consideration of optical effects in the profile of mouldings are omitted here.

†As shown by the instances of perspective illusion previously cited.

which each part has cost a separate study and has had an individual treatment; in place of symmetry we have balance and the unity of impression does not suffer."*

I shall supplement these quotations by another from a more erratic and frequently misleading critic, viz., John Ruskin, who has, however, redeemed many other mistakes, by a marvellously apt and intelligent discussion of the subject of mediæval architectural asymmetry. Mr. Ruskin speaks of

"Accidental carelessness of measurement or of execution being mingled indistinguishably with the purposed departures from symmetrical regularity and the luxuriousness of perpetually variable fancy. . . . How great, how frequent they are, and how brightly the severity of architectural law is relieved by their grace and suddenness, has not, I think, been enough observed; still less the unequal measurements of even important features professing to be absolutely symmetrical."

After some pages of instances he goes on:

"I imagine I have given instances enough, though I could multiply them indefinitely, to prove that these variations are not mere blunders or carelessness, but the result of a fixed scorn, if not dislike, of accuracy in measurements; and, in most cases, I believe, of a determined resolution to work out an effective symmetry of variations as subtle as those of Nature."†

These various quotations point to a general opinion on the part of distinguished authorities, and possibly on the part of a certain portion of the cultivated public, that there is a difference between modern copies of mediæval work and the ancient originals which is not wholly to the advantage of the modern church. The existence of such differences has been materially accented by a series of measurements and of photographically verified observations which I have carried out on behalf of the Brooklyn Museum.‡ In modern church architecture there is a certain smugness of mechanical perfection and of formal regularity which contrasts unfavorably with the free-hand design of the old work. The object of this chapter is, therefore, to enquire whether there is a possibility of the practical application to modern churches of any or some of the refinements which have been recently found in those of the mediæval period.

It is evident that any satisfactory discussion of such a subject must treat the topic of refinements as part of a general and larger theme in which other virtues of the best mediæval churches are included, and in which the sympathetic relation of special individual refinements to these general virtues is considered. This again calls for an exposition of the conditions under which these virtues were developed and for a consideration of the question as to how far these virtues may be revived under wholly different conditions.

Thus, in considering how the monotonous effects of formalism may be avoided in modern churches we have to insist, first, on the absence in modern times of

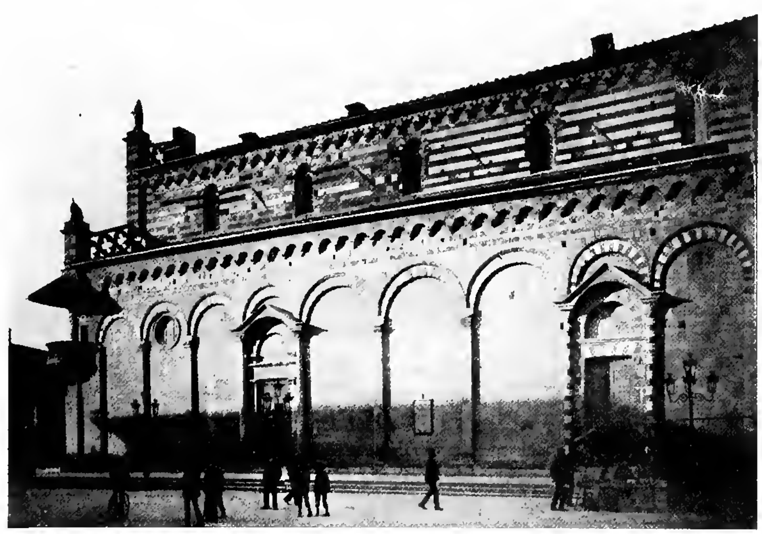


FIG. 2. CATHEDRAL OF PRATO. SOUTH WALL.

Asymmetry in arcades. From left to right the arcade widths are 9.33, 9.40, 10.22, 9.68 (door), 12.17, 12.11, 12.34, 8.85 (door), 9.46. The arcades rise in height 0.40 and the capitals lower in height 0.35. Measures in foot decimals.

Brooklyn Institute Museum Survey Photograph.

*These quotations are translations from the *Histoire de l'Architecture*, Vol. II, pp. 410, 411, 412.

†*Seven Lamps of Architecture. The Lamp of Life.*

‡See the *American Architect*, Aug. 4th, Sept. 8th, Oct. 27th, Dec. 1st, 1909; Jan. 26th, March 26th, 1910.

many of the conditions which formerly counteracted such formalism. For instance, throughout the Early Christian and Romanesque periods in Italy, churches were frequently built with many heterogeneous materials from ancient ruins. This element of picturesque variety, which counts for a good deal in the Pisa Cathedral, for instance, disappeared in Italy about the 13th Century. It certainly could not be invoked now. Neither could many other unpremeditated irregularities of a different character, which give much charm to mediæval building, be reproduced by a less ingenuous and more self-conscious period like our own. Again, throughout the Romanesque and Gothic periods it was the rule that the individual stone carver created his own designs in the matter of capitals and other sculptured details. Thus the capitals of Rheims Cathedral or of the Doge's Palace at Venice were produced under conditions which cannot be revived in days when the original designs for detail are prepared in an architect's office. Even if these designs be individually varied and the repetition of one formula be avoided, the fact that the carver is working from a design which he did not originate, deprives his work of the swing of independent initiative and of the impromptu effectiveness of the old work.

Fig. 3. STA. MARIA NOVELLA, FLORENCE.

The bays, from entrance to transept, measure as follows: 37.60, 38.70, 40.80, 35.35, 27.60, 27.80. Quoted as an instance of perspective illusion by Choisy, *Histoire de l'Architecture*, Vol. II., p. 410. Measures in foot decimals.
Brooklyn Institute Museum Survey Photograph.

The conditions which Choisy so aptly describes and which illustrate the mediæval willing toleration and grateful acceptance of departures from formal symmetry are all obviously lacking in modern work. To dwell on this phase of the matter for a moment longer we might develop it by remembering how many interesting variations of detail are due to the length of time during which a given cathedral was in process of construction and to the fact that the evolution of each successive mediæval style involved changes of detail according to the sequence of time. In both Romanesque and Gothic there was a gradual movement from the simple to the ornate and from the ornate to the complex. Thus the fashions of window tracery, for instance, were changing within periods of ten or fifteen years and from this cause alone there might be endless variety in the window tracery of a single building.

Reducing these various facts to a single statement, they all converge to the free initiative which was exercised by the mediæval artisans. Various refinements were frequently practiced and were undoubtedly of great benefit to the total result, but this result starts with the natural variations of mediæval detail and with the picturesque effects which naturally followed the absence of any prejudice in favor of formal symmetry. These variations were, therefore, the result of the social and economic conditions which distinguish the Middle Age from the modern time. It was also these conditions which produced the refinements or which especially favored their development. The training of the individual mason certainly predisposed him to understand and adopt the instructions as to purposed deviations from normal regularity which might be given him by the master mason. This is not the case now. On the contrary, the training of the modern mason is of a character to prejudice him against any departure from rigid geometrical and mathematical precision.

All these reflections point to the conclusion that any modern effort to revive such architectural refinements as were practiced in the Middle Ages must invert the state of things as they then existed. We must begin with the ultimate result, without going through the intermediate stages of evolutionary process and we must begin with the architect instead of beginning with the mason. The simple fact that many old churches and cathedrals have no refinements and that, generally speaking, the churches which have them in the most varied combination were the more costly, the more important and the more distinguished (which is certainly true of Italy) shows that the refinements were the culmination of a general condition of excellence of which the main condition was simply the absence of methods which produced formal symmetry and the absence of any theory that such symmetry was desirable.

With this conservative preface we may point out an elementary practical advantage to be obtained in modern work by a modern study of this subject on the part of practicing architects. In so far as such architects desire to make their work more interesting and so far as they desire to be free from the set formulas which are sometimes wrongly supposed to be the distinguishing feature of historic styles, it is evident that the knowledge of what was consciously done in mediæval work to avoid the appearance of monotonous formalism may be of great service to them. Without even striving to copy any mediæval form of refinement they may still work for results in the same direction.

It follows that the first practical value of the new point of view to modern architects must be the opportunity to study the matter for themselves and to develop from that study such independent initiative as their own temperament may prompt, inspired by the confidence that they are not violating tradition in depart-

FIG. 4.

The south side of the nave at Chichester, looking toward the choir. This view shows the S-shaped curve in plan and also the widening refinement. The maximum deflection of the concave part of the attenuated S is about 8 inches. The optical effect, as seen at the triforium string-course, is that of a rising curve in elevation near the entrance (on the right), where the curve is convex in plan, and this reverses to the effect of a descending curve in elevation about half way down the nave where the curve reverses to concave in plan. These optical effects are exactly reversed below the level of the camera, as seen in the bases of the piers.

The widening refinement is shown by three plumb-lines. The vaulting-shafts appear to be inclined in straight lines, from the pavement up. The maximum outward inclination is from 4 to 6 inches to a side in about 44 feet (to the vaulting-shaft capitals), but the inclination disappears at the crossing and diminishes near the west entrance. The piers engaged in the west entrance wall are also inclined 2 inches to a side; a remarkable and rather unusual proof of constructive purpose.

Photographed by the writer, for the Brooklyn Museum, in 1914.

ing from mathematical and geometrical symmetry but that they are really faithful to it. For if any one thing strikes the observer in this subject more than another it is the infinite variety of modification which appears in the individual application of any given category of mediæval refinement.

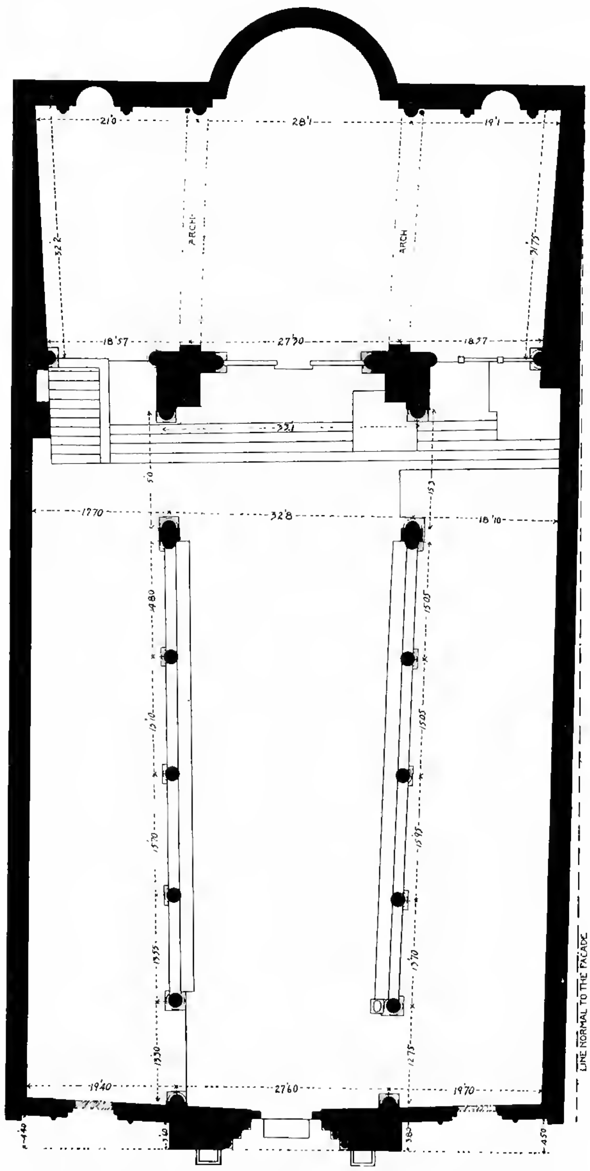


FIG. 5. PLAN OF S. PIETRO, TOSCANELLA.

A predetermined asymmetric plan. The two sides of the projected central façade tally in measure to 0.20. The measures for recession of the façade wings tally within 0.10. The recession of the wings is 0.80 (left) and 0.70 (right). The nave widens in plan 5 feet and the choir narrows in plan 4.70. The widths of the aisles on opposite sides of the church tally within 0.30 at the entrance and they tally within 0.40 at the choir. The aisles narrow to the choir 1.70 (left) and 1.60 (right) with error of only 0.10. The third bays are 2 feet wider than the first or second. The fourth, fifth and sixth pairs of bays are uniformly narrower than the third. The allowance of 0.30 for error in corresponding spaces is only exceeded in one instance (at the entrance), and this excess may not be due to error. *The choir is deflected in plan, as regards the nave, without exterior deflection*, and this deflection therefore cannot be ascribed to irregularity of site nor can it be ascribed to symbolism, as the church has no cross form. This deflection cannot be ascribed to errors due to screening off the choir before building the nave, because the outer walls are straight. Moreover, the apse is decentered 2 feet to the right when the choir alone is considered and without reference to the nave. Measures in foot decimals.

Brooklyn Institute Museum Survey.

We may next enquire what these categories are. In the Italian Romanesque, predetermined variations in the spacing of exterior arcading are quite frequent, especially where Pisan influence is found. Such variations are also common in the Venetian palaces which show Byzantine influence, as Mr. Ruskin long since demonstrated. The cold and tedious formalism of modern Romanesque exterior arcading is very obvious and may be instanced by St. Bartholomew's in New York or the Yale College Chapel in New Haven.

In interior constructive arcading the same predetermined variations are much more frequently found, both in elevation and in plan. They are occasionally connected with schemes of arrangement which indicate that an effect of perspective illusion in the direction of the choir was considered. They are not at all confined to Pisan Romanesque but they also occur generally in the Italian Romanesque and to some extent in the Italian Gothic. They are undoubtedly found to a considerable extent in the Romanesque of Northern Europe. They are very uncommon in Northern Gothic, to my observation.

As regards plan, the twist at the choir is a well-known feature of Northern Gothic and Romanesque. It has been widely explained, generally by sacristans, as having had a symbolic meaning, but this explanation has been finally, and conclusively, shown to be untenable by De Lasteyrie.* The effect of the twist is to increase perspective effect, to give a more picturesque vista, and, generally speaking, to so decenter the church optically as to destroy the unpleasantly formal effects of parallel perspective when the spectator is in the middle of the church. The twisted choir plan is almost unknown in

La Déviation de l'axe des églises, est elle symbolique? Paris, Librairie C. Klincksieck, 1905. De Lasteyrie's conclusion is that the deflected choirs are due to the lack of modern surveying instruments. That this conclusion is also erroneous may be easily shown. I considered this subject in the *R. I. B. A. Journal*, Vol. XV, No. 1, pp. 26-30, 1907, *"A Reply to Mr. Bilson."* Much evidence has also been obtained since the date of that publication, to the same effect.

Italy, as regards the exterior walls, and is only found in churches under direct French influence. Italian churches occasionally show an interior bend in plan, of the arcades at the choir, which does not include the exterior walls. The S-shaped plan is found in notable instances like Chichester, Notre-Dame, Fiesole, and St. Ouen at Rouen. It is also found in the Cathedral of Lyons. This reversing curve is probably the most beautiful and effective of all asymmetric plans. It should be remembered that all curves or bends in plan are seen by the eye as curves or bends in elevation* and that the amount of curve changes with the angle of vision. Thus in any given church any curve in plan produces an infinite variety of curves in elevation from any one given and definite standpoint, according to the height to which the eye is directed. Moreover, the optical effect of any given curve in plan, when seen below the level of the eye, is opposed to the effect above the level of the eye.† Thus, the convex curve in plan is seen by the eye, when looking down, as a concave curve in elevation; but above the eye it appears to be a convex curve in elevation. Therefore any curve in plan produces an infinitely varied effect.‡

*See my *Greek Refinements*, note 4, p. 75 (Yale University Press), with illustration of this fact by a photograph of the interior of the dome of Columbia University Chapel. Fig. 46, p. 73.

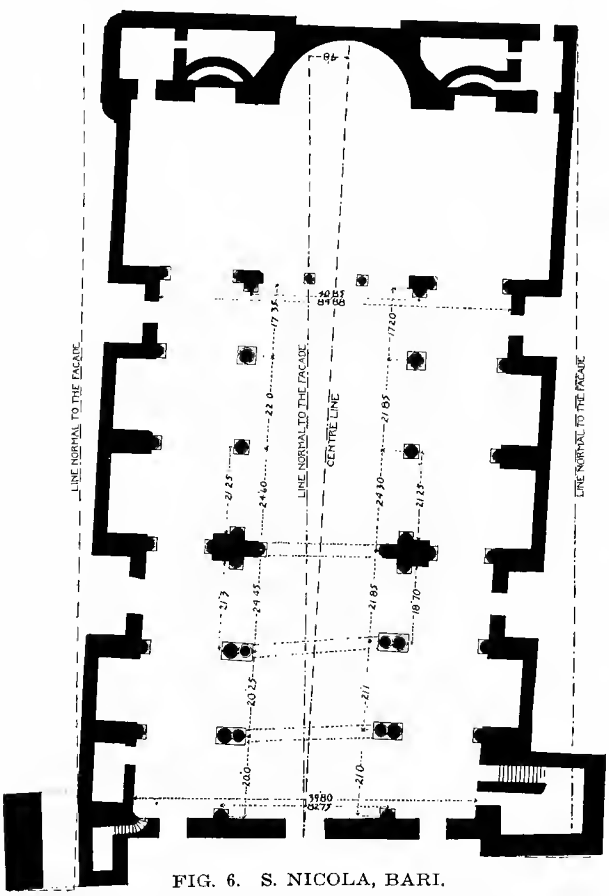


FIG. 6. S. NICOLA, BARI.

Showing the church as having an oblique axis which is 8.60 feet off the normal line at the apse. The nave widens 1.05. The fourth bays are the widest and the others diminish in either direction (diminution toward the choir of about 7 feet). The arches lower in height toward the choir, starting from those at the entrance, 2.97 (left) and 2.36 (right). Measures in foot decimals.
Brooklyn Institute Museum Survey.

FIG. 7. S. NICOLA, BARI.

The nave, photographed by the Brooklyn Museum Survey on the normal central axis, the camera being at right angles to the façade wall; showing the optical effects of obliquities in plan to be effects of obliquity in elevation. These varying effects are complicated by the variation in the obliquity of plan in the transverse arches, which are shown by Fig. 6, but these transverse arcades are absolutely level. Fig. 8 shows that a directly contrary effect is produced when the obliquity of plan is below the level of the eye.

The same philosophy holds of obliquities in plan which are constructed in straight lines. They are always translated by the eye into obliquities in elevation.‖ There are many churches in Italy

†See *Greek Refinements* as just quoted.

‡Mr. Wm. L. Wollett, an architect of San Francisco, believes that the undulation and increased variety of lights and shadows were the main purpose of curvature in plan and this explanation ought not to be overlooked. There is much in its favor.

‖See "The Architectural Exhibition at the Brooklyn Museum" in the *American Architect*, Aug. 4, 1909. Note especially the captions of the illustrations and notes on the illustrations at the close of the article.

FIG. 8. S. NICOLA, BARI.

Commercial photograph, showing the nave from the façade gallery, and above the transverse arcades. This view proves that obliquites in plan below the level of the eye produce an exactly opposite effect to the one obtained when the obliquity in plan is above the level of the eye. Here the transverse arcades appear to rise in elevation toward the right; whereas, in the preceding view of the same obliquity (Fig. 7), they appear to descend in elevation toward the right. This contrast proves that the spectator on the floor of a church nave sees two opposite effects in one and the same obliquity of plan—one effect in elevation below the level of the eye and an opposite effect in elevation above the level of the eye, both effects being produced at the same time and from the same standpoint. This view also shows that the effect of obliquity in elevation increases with the amount of pitch in the angle of vision, and that the effect therefore decreases (on the same plane) with the increase of distance from the observer. Thus the top of the second transverse arcade has less inclination in optical effect than the first, although reference to the plan will show that the obliquity in plan is really greater.

with oblique ground plans, which appear very bizarre when laid out on paper. In actual vision these obliquities are wholly unnoticed, because they are translated by the eye into obliquities of elevation which would be normal in some other position of the spectator, as the result of perspective. The effect is simply to decentre the church, optically speaking, and to deceive the eye as to the standpoint of vision, thus producing an effect of vibration or of optical confusion. An obliquity in plan which deviates thirteen feet from the normal line is wholly invisible in the Cathedral of Cremona.*

The lines of interior arcading are very frequently out of parallel in mediæval Italian churches, when the arcades are laid out in straight lines, and this is especially common in the oblique plans (in which the axis of the choir is not normal to the main central entrance). In these oblique plans the arcades generally diverge toward the choir. Arrangements of arcading in which the arcades converge toward the choir are not common, but they occur, and in these latter cases the same arrangement generally holds for the outer walls. A distaste for parallel lines appears in all these instances and it is remarkable what large variations in measurement of the width between arcades or between walls, at the two ends of a church, are invisible, even after the facts have been measured and realized.

Constructive curves and bends in elevation appear to be rather uncommon in mediæval work, probably because similar but much more varied results were more easily obtained by deflections in plan. Gallery bends in elevation are found in Notre-Dame and in the Pisa Cathedral, but curves and bends in plan are much more frequent in the same Cathedrals. Curves in elevation are found in the Pisa Cathedral and in St. Mark's at Venice.

As regards vertical lines in interiors the Middle Age was addicted to lines of curvature or to bends which have the effect of curvature. Wherever vertical curvature is constructed it must either occur as a bulge or else it must be obtained by a slight outward slope. This latter method was the one adopted, and for obvious reasons, as a bulging vertical curve is clumsy and has an effect of weakness. The same considerations which led the Greeks to avoid a bulging entasis are at stake. The vista in a church nave which employs vertical curvature is therefore very aptly to be compared to the vista between a pair of Greek Doric columns. The slight outward spread of the verticals is also frequently found to occur in sloping lines which are straight from the pavement up. This is doubtless to be explained by a preference for a widening effect toward the springing of the vaulting arches, which gives an effect of spaciousness to the upper part of the nave. Although this arrangement counteracts the converging lines of vertical perspect-

*Plan in *American Architect* for Aug. 4, 1909, p. 42.

ive, it also throws the vanishing point to an infinite distance and thus contributes to an effect of vertical height. The slight widening of the nave in the upward direction is occasionally found in timber-roofed churches in England, but to my knowledge it does not so occur elsewhere. Such occasional practice in England must be due to a tradition borrowed from the Continent and there only applied to vaulted churches. The outward widening effect certainly originated in vaulted churches and is most easily understood by reference to them. The study of this effect will fail if it considers the verticals without reference to the arch which they support. The transition from the vertical to the arch which it supports is much more beautiful when this attenuated horseshoe form is employed. At all events, it is evident that this was the opinion of the mediæval builder.

FIG. 9.

The nave at Lichfield, looking toward the choir. This view shows the bend in plan of the choir toward the north, as seen in the central rib of the vaulting; and the widening refinement. The vaulting-shafts incline from the pavement up, with a bend near the arcade caps, which gives an effect of vertical curvature. The maximum inclination at the center of the nave is about 12 inches to a side, up to the top of the clerestory windows (about 46 feet), or about 10 inches up to the springing of the vaulting (about 38 feet). The inclinations diminish from the center and disappear in the crossing piers and in the piers next the west entrance. Thus, at the height of the clerestory there are resulting curves in plan, concave to the nave, which are practically invisible from the floor of the nave, but which are shown by Fig. 10. There appears to be no widening in the choir, which is of a later period (late 14th century).

Photographed by the writer, for the Brooklyn Museum, in 1914.

The Italian mediæval churches very generally construct the pavement with an upward slope toward the choir and this practice also occurs in Northern Europe, for instance, at Chartres, where the pavement rises three feet seven inches between the west wall and the choir. The great difficulty of verifying the existence of such slopes by the eye, without levelling, when one is looking for them or querying their existence, proves that they must have a considerable illusive effect in increasing effects of distance in the direction of the choir and this may, very probably, have been the motive of this practice. It is difficult to conceive how this method can be of much service in churches which employ pews. Generally speaking, pews are very fatal to the effect of a church.

Perhaps the most daring and remarkable development of mediæval refinement was the construction of façades with a forward inclination. The known instances are not numerous and they occur only in churches of the first rank. The Cathedrals of Peterborough, Paris, Ferrara, and Pisa, the churches of St. Mark's at Venice, of San Michele at Pavia and of San Ambrogio at Genoa (Renaissance period) are the

FIG. 10. LICHFIELD CATHEDRAL.

Curve in plan of the roof parapet, north side; about 15 inches deflection in a length of about 112 feet. This obviously constructive curve, which also appears on the south side, is connected with the construction of the interior widening refinement. See Fig. 9. Brooklyn Museum photograph, 1914.

instances best known to me. There are some doubtful points about the façade of San Ambrogio at Milan, but I believe it to be a constructive case. A recent examination of Peterborough has convinced me that it is a good constructive case. The façades of Ferrara and San Ambrogio at Genoa are the only ones among those quoted which lean forward in a straight line. The second story of St. Mark's façade is perpendicular and the lower story bends toward the perpendicular. The façades of San Michele at Pavia and San Ambrogio at Milan both bend toward the perpendicular. The upper stories of the cathedral façades of Paris and of Pisa are perpendicular and the intervening stories diminish the inclination, as compared with the lower stories. The upper story of the Peterborough façade is nearly perpendicular. These facts are quoted to suggest that much care was taken in such cases to avoid accidental increase of inclination and consequent downfall. A close study, for instance, of the façades at Paris and Pisa shows that they are absolutely stable from an engineering point of view. This also appears from the absence of movement during so many centuries.

It is probable that a wider knowledge as to the use of refinements in mediæval building will promote experiments in the same direction in modern churches. They will undoubtedly increase the expense of construction very considerably and it therefore appears that some education of the cultivated public as to the advantage of such refinements must precede their use to any great extent by modern architects.

UNITARIAN MEETING HOUSE, SUMMIT, N. J.
MR. JOY WHEELER DOW, *ARCHITECT*.

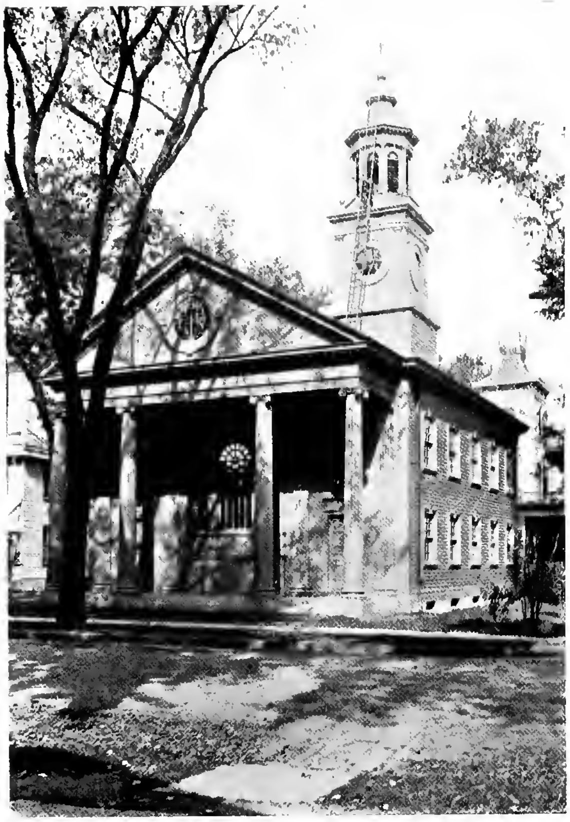
THE DEVELOPMENT OF THE MEETING-HOUSE

WITH PARTICULAR REFERENCE TO ILLUSTRATIONS OF FIRST CHURCH OF DANBURY, CONN. (PLATES 21-31.) MESSRS. HOWELLS & STOKES, *ARCHITECTS*

BEFORE the fire of London in 1666, Sir Christopher Wren had already, at the command of King Charles II, drawn plans for remodeling St. Paul's Cathedral. In the plan he showed a vast church without aisles or transepts, merely a great meeting-house of worship, as the most expressive of the preaching, non-ritualistic, Protestant faith. These plans, although approved of by the King, were thought to depart too radically from the traditional forms, and were disapproved by the clergy in power, to the disgust of Wren, who did nothing further.

Then came the fire, destroying much of London, including fifty churches. Again Sir Christopher drew plans for St. Paul's, but he got with them this time express directions from the King that he was to vary them as he saw fit without reference to the clergy, and from these plans grew the church completed in 1710. He went forward with a vast number of other churches, which he treated mostly in what he called "a good Roman style," as distinguished from "The Gothlike rudeness," and these many classic spires from the prototypes of our more lively New England spires executed a century or more later.

The English spires were stone and their superpositions and orders had to be translated here in wood, for we had neither the money nor facilities to work in stone. Out of this fact grew the attenuation and the consequent grace and lightness of our New England church spires. Except in the verticalities of the Gothic Cathedrals nowhere in the world can be found a more aspiring form than



UNITARIAN MEETING HOUSE, SUMMIT, N. J.
MR. JOY WHEELER DOW, *ARCHITECT.*

one of these steeples arising from our elms and sparkling against our sky.

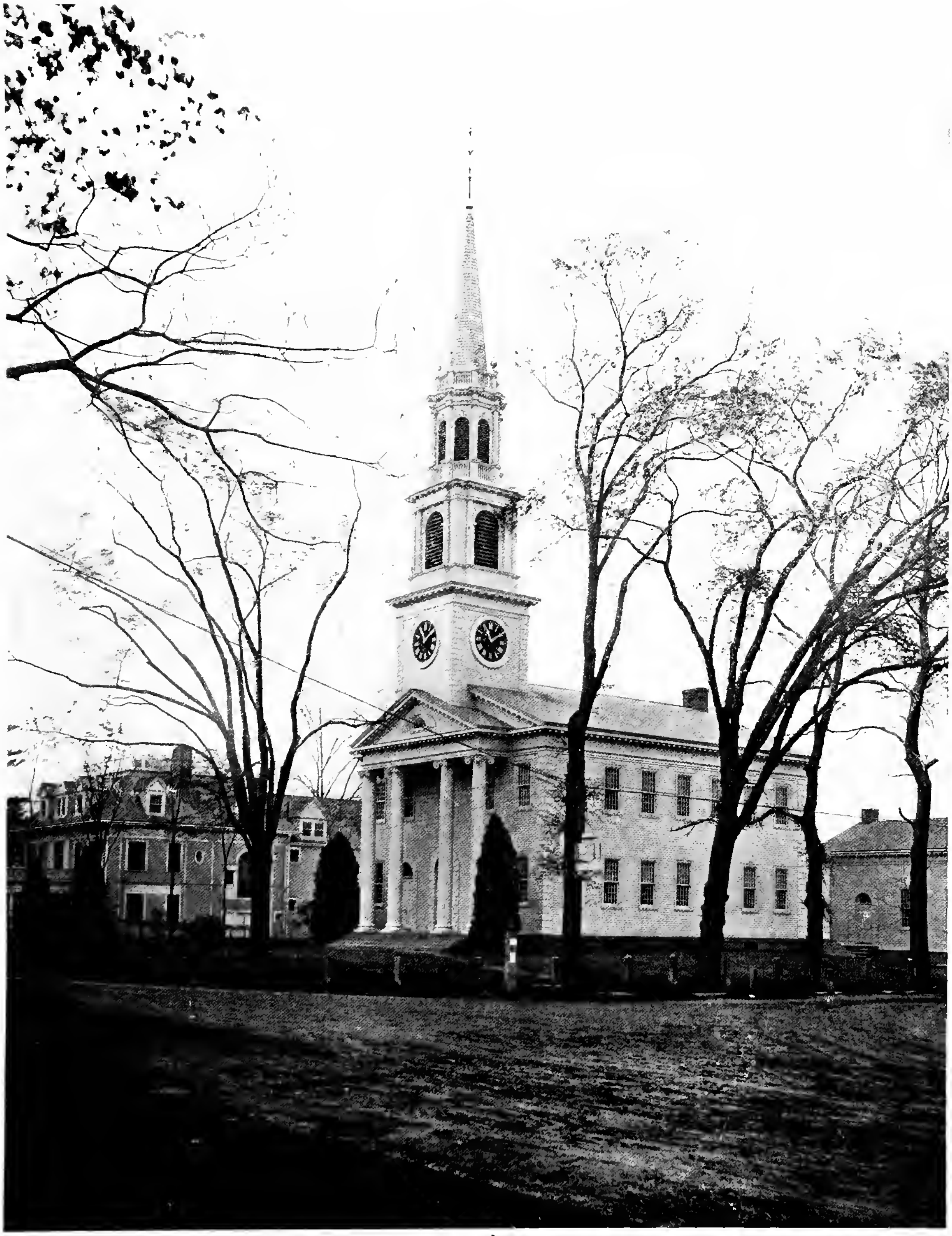
In the early days it was customary for the Colonists to build within half a mile of the meeting-house; around it stood grouped the stock, the jail and the gallows. This meeting-house was the spiritual correctional, but was also open for all forms of protection of man and beast from danger. Later the settlements spread out and the meeting-house became "as a light upon a hill," a beacon to warn off hostile approach. The earlier meeting-houses were mostly square in form and of box-like appearance, but as the Colonies prospered and money accumulated, more imposing buildings rose, for the greater part apparently, where the old ones were burned down, and the architectural development of the church and steeple kept pace.

Such architects as Ascher Benjamin, Bulfinch, Ithiel Town and others turned to the engraved plates in the large works issued just before this time on English and French architecture, mostly the former, and translated the designs there found into wood, often with remarkable delicacy and feeling.

At this time the meeting-houses in many communities had become handsome, well-appointed buildings with carved moldings and capitals inside and an exterior which must often have gone beyond the interior in decoration if we can judge from Mrs. Bacon's quaint quotation from the archives of a certain meeting-house, which is recorded as treated thus: "The body of the church was painted a bright orange; the doors and bottom part a warm chocolate colour; the window jets and corner boards and weather boards white. This church possessed an 'eleclarick rod' and boasted it was the 'newest, biggest and yallowest' in the country."

UNITARIAN MEETING HOUSE, SUMMIT, N. J.
MR. JOY WHEELER DOW, *ARCHITECT.*

Thus the development went forward, of what is now recognized and classified as an architectural style and called, for want of a better name, "Colonial." The finer



FIRST CONGREGATIONAL CHURCH, OLD LYME, CONN.

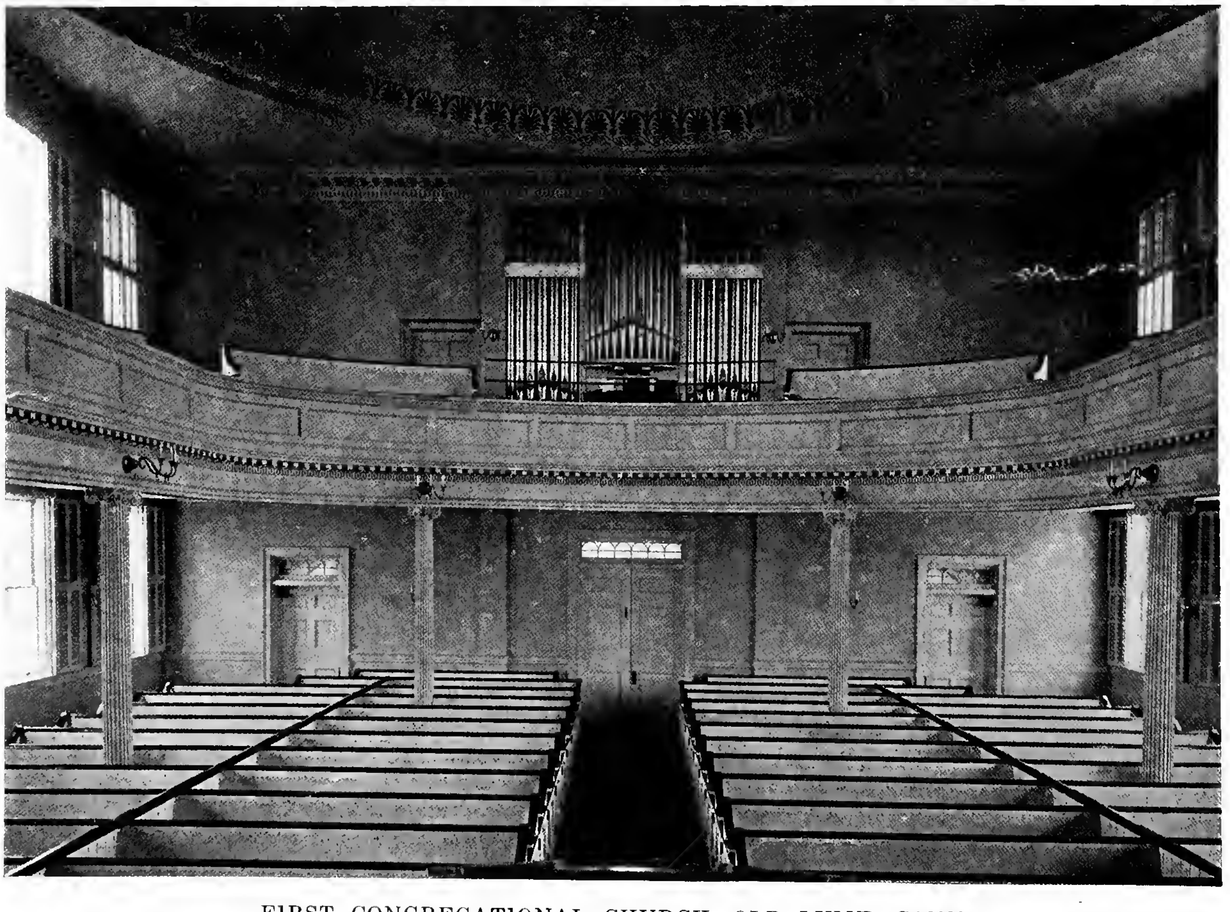
MR. ERNEST GREEN, *ARCHITECT.*

examples can naturally be found in the more important towns, where culture and intelligence made people appreciative. The style was perfected about 1830 in the large towns, and after that began to decay, so that the later examples, except certain cases of the Greek revival, are often not worth notice. Many of the finest of the recorded examples have been burned or destroyed in the last generation, and this is particularly called to mind by the sad loss of the beautiful church at Lyme, Conn., last year; but many remain and many New England towns far from railroad stations to-day will richly repay a carriage or automobile pilgrimage to see its delicate steeple rising amid its equally delicate and characteristic elms.

And this brings us to the subject of our illustrations—the meeting-house of the First Church of Danbury, Conn. (See plates 21 to 31.)

This church is new in itself, but old in its antecedents, both in the dignified history of the Church Society which it represents and the architectural style which it embodies. New and original as a whole, and built to correspond exactly to the needs of the congregation which it is to house, this church, nevertheless, is purely archeological in that only motifs and parts have been used in its make-up for which a prototype could be found in the best Colonial architecture. Not an exact prototype, perhaps, but a sentimental prototype at least in the manner of treating column and cornice and proportion.

The steeple has been spoken of as of the Bulfinch type, perhaps because Bulfinch's best-known church that is still standing at Lancaster, Mass., has a tower which ends in a domical form. In his church, however, the tower is very short and thick and the dome large. In the Danbury Church we have the spire of the



FIRST CONGREGATIONAL CHURCH, OLD LYME, CONN.
MR. ERNEST GREEN, *ARCHITECT.*

FIRST CONGREGATIONAL CHURCH, OLD LYME, CONN.
MR. ERNEST GREEN, *ARCHITECT.*

most developed type. It refers itself most closely, perhaps, to the spire of the United Church of New Haven, designed by Ithiel Town, except that the Danbury spire is, upon comparison, more lofty and elongated than his.

The portico shows free-standing columns, as in the church at Guilford, Conn., although at Guilford there are only four columns, while at Danbury there are eight grouped in pairs. The grouping of columns in this way is, perhaps, not quite archeological, but its effect in this case, combined with the grouping of the urns on the balustrade, gives a stateliness which the more naif arrangement of the early churches possibly missed.

Upon entering the vestibule, through one of the three main doors, one finds that the interior is marked by the same distinguishing simplicity and faithful adherence to tradition. The doors to the body of the church are mahogany, and these, with the star rail at either end of the vestibule, contrast charmingly with the dead white of the woodwork and plaster walls. An accompanying illustration from this portion of the church shows how well the lighting fixtures harmonize with the old-time flavor of dignity and restraint.

The first glance into the main body of the meeting-house reveals a striking combination of white plaster and woodwork, relieved again by the mahogany pulpit and rail, and by the backs and ends of the pews. Throughout the large auditorium, which with the gallery seats nearly nine hundred people, there is a wealth of delicate plaster modeling and wood carving. This is particularly marked in the organ and in the panels in the sides of the front, designed in a delicate open-work pattern to permit transmission of sound from the end pipes. It is in the organ particularly that the architects have had the fullest

OLD MEETING HOUSE, WEST ROXBURY, MASS.

opportunity for carrying forward into new fields the spirit of the Colonist church builders. There were, of course, no precedents, since our Puritan forefathers would have looked upon such a luxuriously appointed instrument as a manifestation of rank papistry. The central portion of the tracery panels is repeated in the upper part of the rear wall, back of which is located the echo organ.

Windows below and above the gallery serve to illuminate with great brilliancy this white interior. These windows are purely archeological, even to the extent of having imperfect, wavy glass for the small panes.

Instead of filling the gallery entirely with pews, a single line of these extends around the three sides of the church, just below the outside aisle, and in front of this line the gallery is divided into boxes furnished with Windsor chairs, harmonizing in color with the mahogany trimmings.

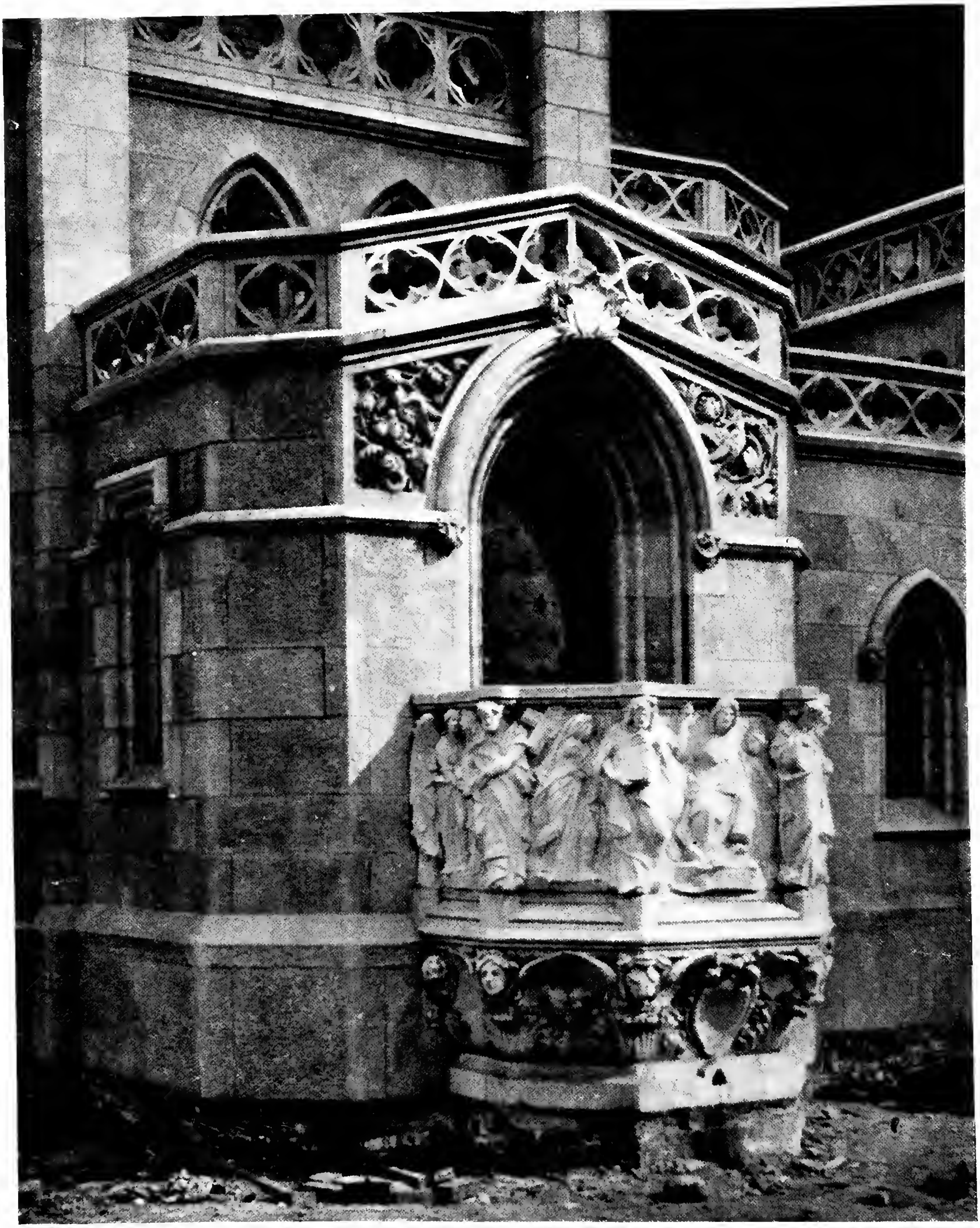
One touch of modernity is the use of cast-iron colonettes to support the gallery of the interior, thereby getting more slender supports, which interrupt the eye less than would be possible in wood. Otherwise, the interior is as carefully studied archeologically as the outside. In fact, the gallery is inspired from the gallery of the old West Church in Boston, Mass., designed by Ascher Benjamin.

Another modern touch and one which we trust will tend to longevity of this church, is that it has a modern heating apparatus, instead of depending, as our forefathers did, upon large stoves set on a wooden floor. There are no radiators in sight, of course, to mar the simplicity of the interior, for these have been placed in the space under the broad window sills. The latter are flat, with a white-painted iron grating let into them flush with the surface.

There is the inevitable red carpet runner for the aisles and the equally inevitable red cushions and carpet-covered footstools for the pews.

Other concessions to the spirit of the age are the electric lights, and the accousticon, or system of pew telephones, for those members of the congregation who otherwise would be unable fully to hear and enjoy the service.

OLD MEETING HOUSE, WEST ROXBURY, MASS.



OUT OF DOORS PULPIT, GRACE CHURCH, NEW YORK
MR. W. W. RENWICK, *ARCHITECT*

CHURCH VENTILATION

By D. D. KIMBALL

PRESIDENT AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. MEMBER NEW YORK STATE COMMISSION ON VENTILATION.

"The Art of Ventilation was born too soon." Thus does Prof. C. E. A. Winslow begin his admirable paper on "The New Art of Ventilation."*

DURING recent years there has been a vast amount of discussion on the subject of ventilation and voluminous papers have been written attacking the subject from all sides. Unfortunately the phase of the agitation which has received the greatest publicity has been that making sensational, ill-founded and unscientific attacks tending to destroy faith in ventilation generally. To the interested and careful observer or student the results of the best work and experimentation point to the confirmation of our faith in ventilation, and most assuredly so in connection with all auditoria. During this process, however, Prof. Winslow's remark, quoted above, has been amply justified, but the formerly accepted quantitative and qualitative standards of ventilation, far from being abandoned because of recent research, are rather reinforced and reestablished.

Peculiar as it may seem, the standards remain the same but the bases thereof have been changed absolutely. The old standards were based on the chemical quality of the air only. The new standards, while recognizing the desirability, and even the essentiality, of pure air, lay the greater stress on the physical properties of the air. Old standards were based on the carbonic acid and oxygen content of the air; the new standards are based upon the requirements of temperature, humidity and air movement.

And so it happened that the art of ventilation, born too soon, was vulnerable, and therefore subject to failure because its standards were ill-founded and incomplete. Nevertheless, ventilation in the past has accomplished much good. The art of ventilation is now given a proper basis, and, being complete, will be found to meet all requirements and be capable of proving its worth.

The old standards of air quantities for ventilation were based upon a certain permissible proportion of carbon dioxide in the air of occupied spaces during the period of occupancy, on the dilution theory, the essence of which being that it was the province of ventilation to so dilute the air of the occupied space that the carbon dioxide could not exceed a certain proportion in the composition of the air of the room.

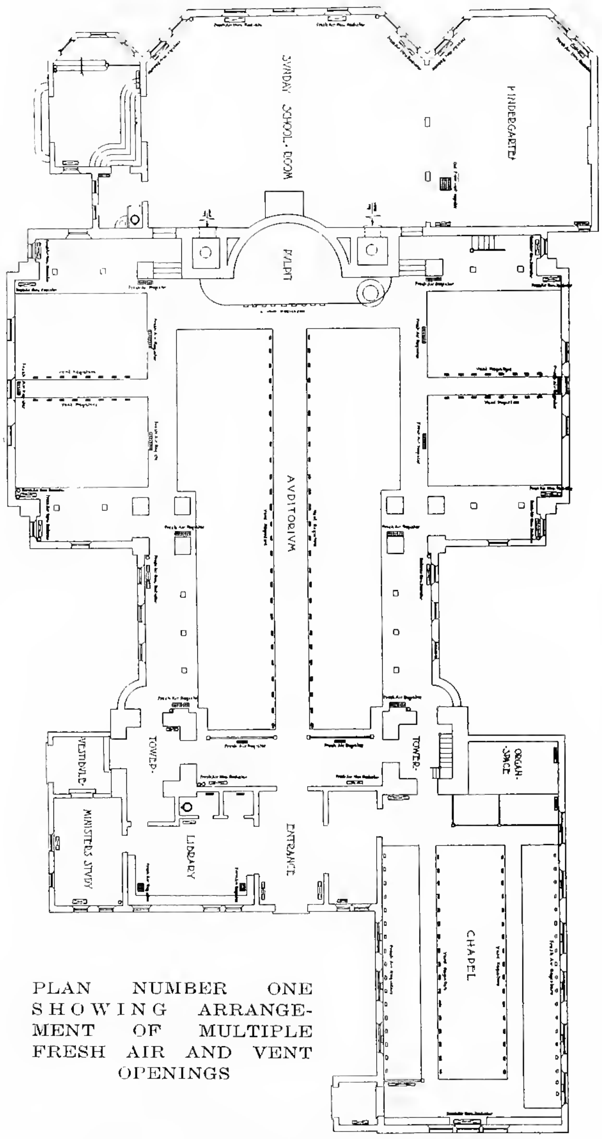
Breathed air suffers certain chemical changes, the carbon dioxide being increased and the oxygen being decreased, but the accumulation of carbon dioxide or the decrease of oxygen to a harmful extent in a church auditorium is an impossibility. Leakage about doors and windows, and even through the walls and roof, will provide such a dilution of the air that the carbon dioxide cannot increase to an extent which even approaches the danger point.

In outdoor air the carbon dioxide averages four parts in ten thousand and the oxygen about twenty-one per cent. In badly ventilated auditoria the carbon dioxide will rarely reach twenty parts in ten thousand and the oxygen will not fall below twenty per cent. In experimental work, subjects have been exposed to an atmosphere containing over two hundred parts of carbon dioxide in ten thousand and seventeen to eighteen per cent. of oxygen without ill effect so long as the temperature, humidity and air movement were properly regulated. However, no one contends that long-continued subjec-

*See transactions of the Fifteenth International Congress on Hygiene and Demography, held at Washington, D. C., September 23rd to 28th, 1912.

tion to such conditions may not be harmful. But it has been clearly demonstrated that proper temperature, humidity and air movement are the first essentials to proper ventilation.

Eight parts carbonic acid per ten thousand parts air have been generally accepted by Engineers as the proper standard of air quality for air in auditoria. With this standard as a basis the following simple formula has been used for determining the air volume per capita per minute which must be supplied by the ventilating system.



PLAN NUMBER ONE SHOWING ARRANGEMENT OF MULTIPLE FRESH AIR AND VENT OPENINGS

FIRST PRESBYTERIAN CHURCH, BUFFALO, N. Y. (SEE PAGE 30)

$$V = 10{,}000 \frac{N\,G}{S - P}$$, in which

V = the cubic feet of fresh air required per hour, N = the number of persons in the room, G = the cubic feet of CO_2 given off per hour per person (usually taken as .6), S = the standard of purity of air to be maintained in the room, and P = the standard of purity of outside air, usually taken as 4).

With the desired standard of purity taken as 8 the formula would read

$$V = 10{,}000 \frac{N.6}{8 - 4}$$

This, figured on the basis of a single individual, would give a resulting standard of air supply of 1500 cubic feet per hour. In practice eighteen hundred cubic feet has generally been regarded as the correct standard.

It may be claimed by some that the spaciousness of a church auditorium makes such a rule inapplicable, but of what value is the air in the upper portion of a room from a ventilating standpoint? If it could be brought down into the occupied space, or if the audience could be lifted into this upper strata of air, such a claim might be justified, but only then. The fact remains that this upper air does not become available for the purposes of ventilation.

The following authorities are quoted on the volume of air required for ventilation in auditoria for systems operating on the dilution principle:

Carpenter	1000 to 2000	cubic feet per hour
Allen	2000	" " " "
Fletcher	1200 to 1500	" " " "
Harrington	2000	" " " "
Rietschel	2148	" " " "

The average of the above is well above 2000 cubic feet per hour, which is approximately that which has been generally used, and it has been amply demonstrated that this volume of air makes possible satisfactory results in auditorium ventilation.

The first of the new standards of ventilation, above mentioned, is temperature. While the standard for temperature recommended for auditoria has not been changed the seriousness of overheating is now realized. Formerly this was regarded as a matter of discomfort only; now it is realized that in causing discomfort it disturbs certain physiological functions, often exceeding the capacity of adjustment of the vaso-motor system, promoting depression, lassitude, headache, dizziness, and, in some cases, a rise in body temperature, which, if carried to extreme may develop symptoms of sunstroke. Much less harm results from underheating than from overheating, and yet it is the former which is most noticeable and which will arouse the most resentment. More cold and serious illnesses result from an overheated, stuffy, humid atmosphere in an ill-ventilated room than from a cold room.

The desirable temperature for auditoria, as stated by various authorities, is as follows:

A. Morin . . .65 to 68 degrees
W. N. Shaw .58 to 63 degrees
J. W. Thomas .65 degrees

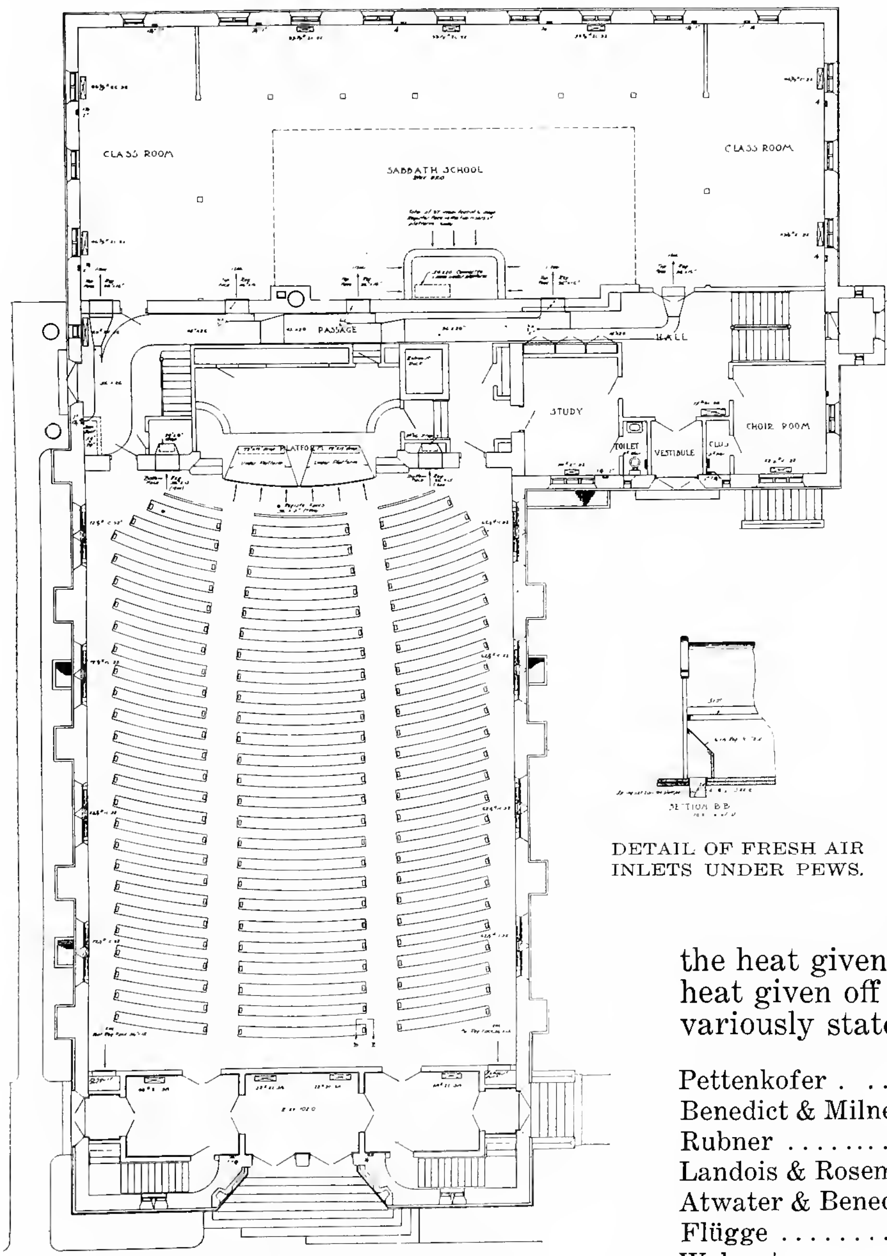
It is the opinion of the writer that 62 degrees to 66 degrees is the most desirable standard; 62 degrees to prevail upon the entrance of the audience and 66 degrees to be the maximum temperature attained during the period of occupancy.

Assuming a temperature of 62 degrees upon the entrance of the audience it can be shown that only by the use of an efficient ventilation system may the temperature of the room, when occupied, be controlled or be kept within or near the maximum prescribed.

One of the most serious elements in the heating and ventilating problem as applied to auditoria is the heat given off by the occupants. The heat given off by human beings at rest is variously stated as follows:

Pettenkofer	400	Heat Units per hour
Benedict & Milner	375	" " " "
Rubner	380	" " " "
Landois & Roseman	368	" " " "
Atwater & Benedict	366	" " " "
Flügge	495	" " " "
Wolpert	400	" " " "

Discrepancies arise from the variableness of this factor of heat production. The heat produced in the body varies with



PLAN NUMBER TWO, FIRST FLOOR—HEATING AND VENTILATING SYSTEM

SECOND UNITED PRESBYTERIAN CHURCH, WILKINSBURG, PA.

MESSRS. INGHAM & BOYD, *ARCHITECTS.*

DETAIL OF FRESH AIR INLETS UNDER PEWS.

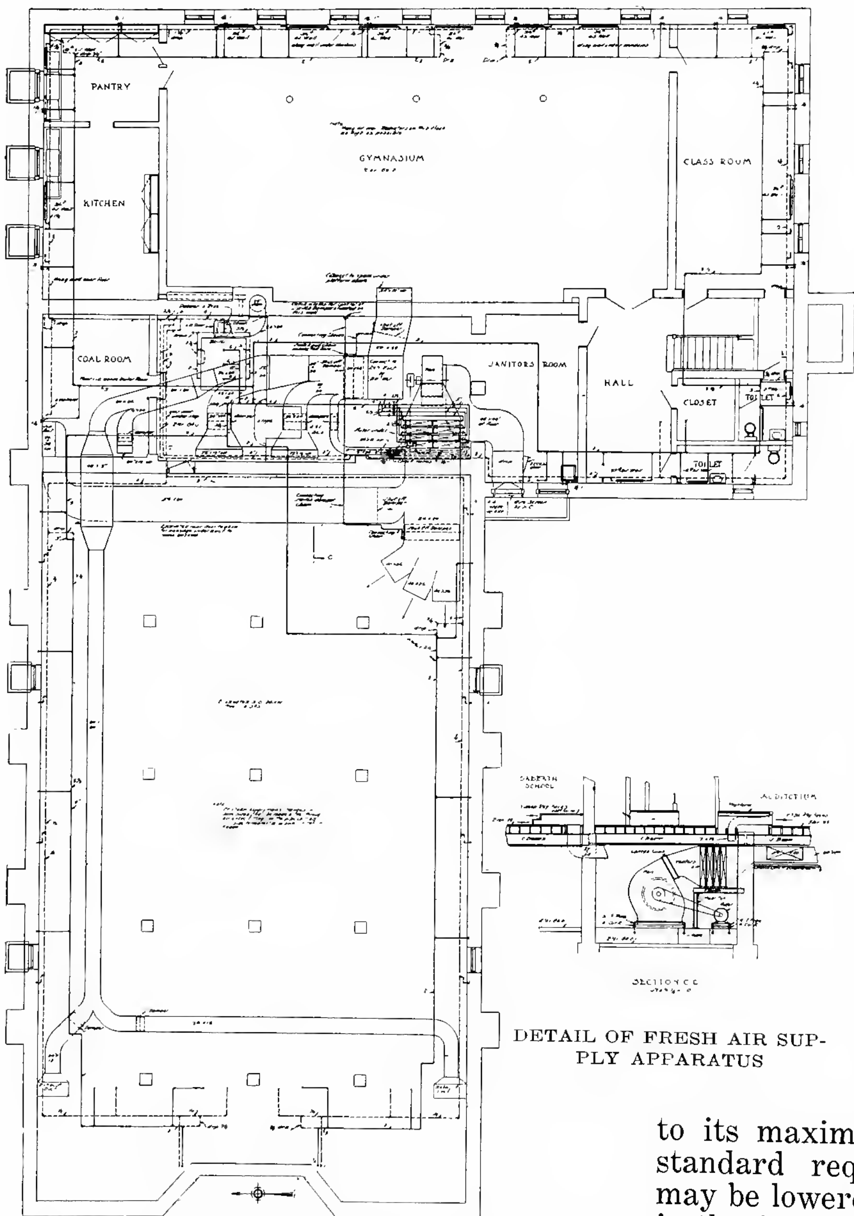
the size of the body, the activity, the food consumed and the dress. 400 B.T.U. per hour (which is approximately the average of the above) is the generally accepted figure representing the hourly heat elimination from the human body at rest.

Four hundred heat units will heat approximately 2000 cubic feet of air through a range of ten degrees. It is generally agreed that the temperature of the air entering a room by means of a ventilating system may not be more than ten degrees less than the room temperature without causing discomfort or endangering the health of the occupants of the room. Thus is fixed, on a new basis, the standard of 2000 cubic feet per hour per occupant, or as frequently used, 30 cubic feet of air per minute per occupant.

Based upon a temperature rise of five degrees in the ventilating air Shaw determines that the air to be supplied should be 3000 cubic feet per occupant per minute. Evidently this calculation involved is based upon some other figure than 400 B.T.U. for the heat elimination from the human body.

It may be urged that the cooling effect of the walls, windows and roof will offset a portion of this heat increment. Manifestly in mild weather, when ventilation is most needed, this is not the case. In cold weather the church must be warmed to not less than 62 degrees upon the entrance of the audience. The cooling effect of the walls and windows must be constantly counteracted by the heating system, else those sitting near the walls, windows and doors will become chilled because of air leakage and heat absorption, while those in the central portion of the auditorium will in no case be relieved by the cooling effect of the walls, windows and doors.

Or it may be said that the church is seldom used to its maximum capacity and thus the standard requirements for ventilation may be lowered. An offset to this exists in the fact that the ten degrees differential between the entering air and room temperatures were much better five degrees, as recommended by Shaw, Thomas



DETAIL OF FRESH AIR SUPPLY APPARATUS

PLAN NUMBER TWO, BASEMENT—HEATING AND VENTILATING SYSTEM

SECOND UNITED PRESBYTERIAN CHURCH, WILKINSBURG, PA.

MESSRS. INGHAM & BOYD, *ARCHITECTS*

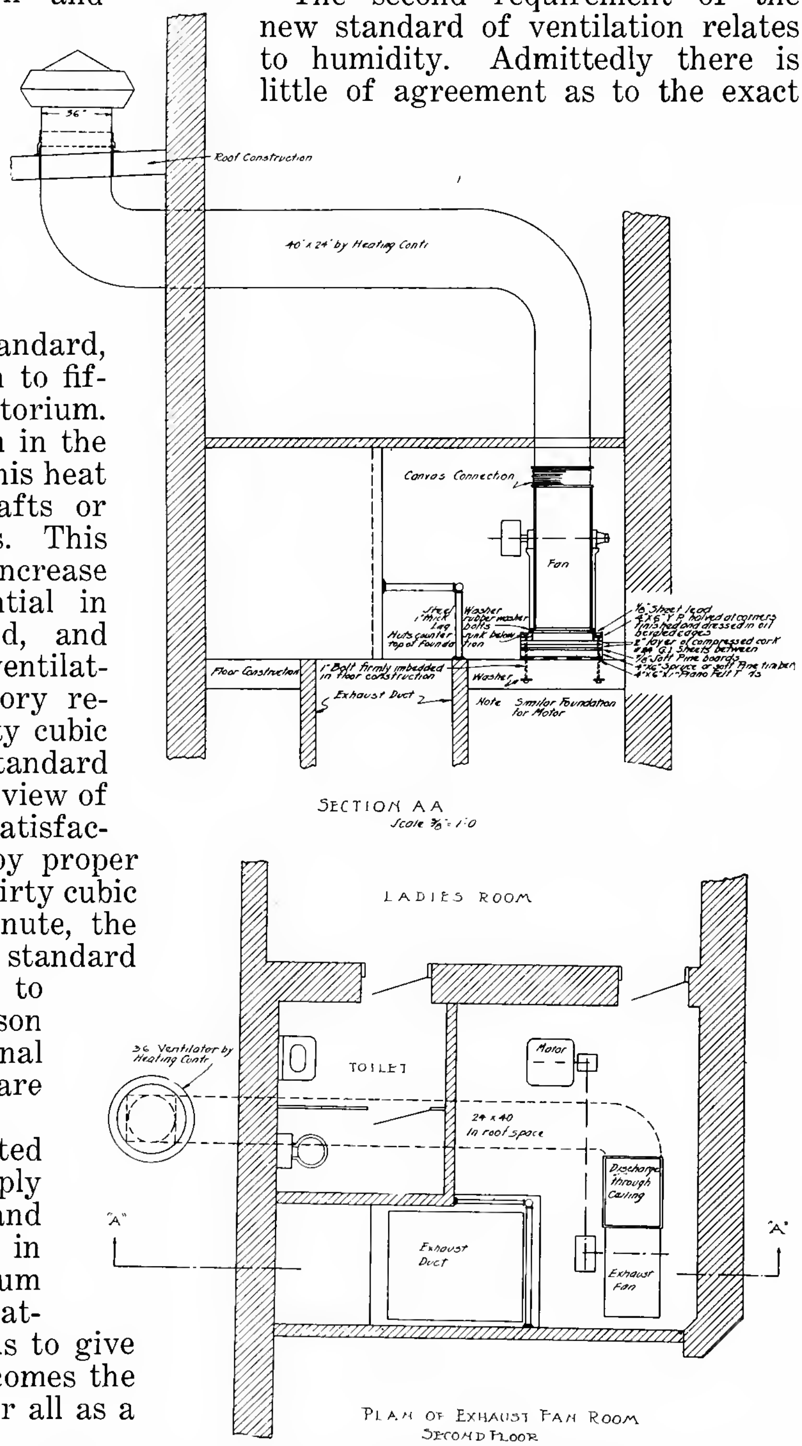
and others, but this would require not less than fifty cubic feet of air per person per minute. Thirty cubic feet of air per person per minute has made possible entirely satisfactory results, with conditions as they have been found to exist, and at reasonable installation and operating costs, both of which would be largely increased with fifty cubic feet of air per person per minute as the standard.

As a matter of fact the heating effect of lights and occupants on the air supplied by the ventilating system, with thirty cubic feet of air per person per minute as the standard, will be found to equal fourteen to fifteen degrees in a well-filled auditorium. This involves a serious problem in the diffusion of the air to take up this heat increment and to prevent drafts or overheated and stagnant areas. This is equivalent to a fifty per cent. increase over the ten degree differential in temperatures above mentioned, and only skillful designing of the ventilating system will give satisfactory results. The adoption of the fifty cubic feet per person per minute standard will lessen this difficulty, but in view of the oft demonstrated fact that satisfactory results can be obtained by proper designing and operation with thirty cubic feet of air per person per minute, the writer does not believe that this standard need be changed from thirty to fifty cubic feet of air per person per minute, or that the additional installation and operating costs are justified.

Experience has demonstrated that a reduction in the air supply of the ventilating system and lessened satisfaction go hand in hand. Even though the maximum demand is made upon the ventilating system but rarely, if it fails to give satisfaction when the demand comes the system is put down once and for all as a complete failure.

A properly designed system of church ventilation supplying and exhausting thirty cubic feet of air per occupant per minute should give satisfactory results, but a system handling a less volume of air, say twenty cubic feet of air per occupant per minute, will surely involve difficulties from overheating, cold drafts or stagnant areas.

The second requirement of the new standard of ventilation relates to humidity. Admittedly there is little of agreement as to the exact



DETAILS OF EXHAUST APPARATUS—NOTE, ESPECIALLY, FAN FOUNDATIONS (SEE PAGE 31)

SECOND UNITED PRESBYTERIAN CHURCH, WILKINSBURG, PA.

desirable standard of humidity, but there is a very general agreement that in ordinary temperatures the relative humidity should not be less than thirty per cent. nor greater than sixty per cent. Witness the following authorities:

Wolpert	40-60%	Rubner	30-60%
Oesperlen	40-60%	Riepzchel	30-40%
Scherer	30-60%	Richardson	40-60%
Paul	40-60%	Shepherd	30-55%
Rietschel	40-60%	Brefflar	40-50%
Smith	50-60%		

Only in cold weather will the relative humidity in a church, when warmed, be less than thirty per cent. before occupancy. Moisture given off by the occupants of the room will, except in extremely cold weather, shortly raise the humidity of the room above the minimum standard named. For this reason, and the further reason that subjection to properly warmed air of slightly less than thirty per cent. relative humidity for short periods can cause neither uncomfortable feelings nor harmful effect, artificial humidification of auditoria is not necessary.

The effect of dry air is to produce a rapid evaporation of moisture from the surface of the skin, causing a feeling of coldness which can only be overcome by a higher room temperature. Excessively moist air, if of a low temperature, causes a feeling of coldness because of the rapid absorption of heat from the body by the moist air, while this moist air, if of a high temperature causes a feeling of heat and discomfort because it fails to take up, by the process of evaporation, the moisture from the pores of the skin, and in so doing it fails to cool the body in failing to take up the latent heat of evaporation.

Temperature and humidity are closely interlinked. A high temperature combined with a high humidity is vastly more uncomfortable than a low temperature with high humidity. Unfortunately high temperature and high humidity are frequently coincident in auditoria, both being principally due to the effect of the audience.

The moisture given off by the human being at rest is stated by Thomas to be one-twelfth of a pound per hour and by Milner and Benedict to be one-fourteenth to one-twelfth of a pound per hour and by others at approximately this same amount. In a properly ventilated auditorium this moisture cannot cause excessive humidity in the air of the room. Even in an unventilated church this moisture will not, save in very mild weather, cause excessive humidity in the general air of the room, but, and herein lies the crux of the whole matter, without the influence of the ventilating system the heat and moisture given off from the bodies of the persons in the room remain within the immediate vicinity of the person, in the form of a blanket of hot moist air immediately surrounding the body, causing all of the discomfort which would accompany a general high room temperature with high humidity.

In confirmation of these views reference may be made to Dr. Leonard Hill's experiments in which he placed subjects in a small closed chamber having no ventilation, keeping them therein until the increase of carbon dioxide and the decrease of oxygen greatly exceeded that ever found in the air of an auditorium. The air became so bad that attempts of the subjects to light cigarettes were fruitless. The temperature and humidity within the chamber became very high and movement of the air was lacking. The discomfort of the subjects became marked. Breathing of outside air through a tube produced no relief. The agitation of the air by means of electric fans produced instant relief which continued until the temperature and humidity further increased. The result of this experiment has been confirmed by other investigators.

Unless an ample movement of air of a proper temperature and humidity is assured the temperature and humidity of the air surrounding the body become excessive and a severe tax is imposed upon the delicate machinery by means of which the bodily temperature is regulated. This system governs the flow of the blood to the skin for the purpose of giving off such heat as becomes necessary to maintain an equable bodily temperature. If the brain or vital organs are robbed of their blood supply in this process, dullness, inattention and discomfort inevitably result. Further, the overheated auditor, in passing from the hot room to the cold air outside, is rendered susceptible to chills and the danger of colds, bronchitis and other diseases of the respiratory system.

It is most important to realize that the entire surface of the body demands proper atmospheric conditions for the maintenance of comfort and health. It may be said that, in effect, the entire surface of the body breathes and that it is far from sufficient to consider the respiratory system alone in the consideration of the ventilation problem.

Thus we progress from the old views which merely required a dilution of the breathed air to the new standard which demands that we provide for all of those conditions which make for comfort and health, in doing which we evolve a process of body bathing with fresh air of proper temperature and humidity.

The so-called "chimney effect" of bodily heat and vapor is altogether insufficient to prevent the formation of a hot, moist body aerial envelope. In fact, this "chimney effect" of bodily heat and moisture, stated by Thomas to be equal to approximately one inch to two inches per second in air movement, is so slight as to be of no moment in the matter of a relief from oppressive atmospheric conditions or in determining the type of the ventilating system to be used. So slight, in fact, is this effect that the cooling effect of walls, windows, doors and roof much more than offsets the alleged "chimney effect."

For the removal of this envelope of hot moist air a definite air movement in the immediate vicinity of every occupant of the room becomes essential. This does not mean currents of air here and there in isolated sections of the room but a thoroughly diffused and reasonably constant movement of air in every portion of the occupied space of the room, not in the forms of drafts but in the form of a gentle motion of air throughout the occupied portion of the room, which, while accomplishing the purpose intended, is not sensible as moving air to the occupants of the room.

The permissible velocity of air surrounding the body is given as one and one-half feet to two feet per second by Boyd, two feet to three feet per second by Fletcher, and two feet to three feet per second by Parke. The author regards one and one-half feet per second as the desirable limit of this air movement, but if the ventilating air is properly diffused no such velocity of air movement is necessary to give perfectly satisfactory results.

In an upward or downward current ventilating system (as commonly used in theatres) the velocity of air movement based upon gross floor area rarely exceeds ten feet per minute. Although this air movement may seem slight it is sufficient to accomplish its purpose, but it must be positive, constant and cover the entire occupied area of the room.

Such results can only be secured by means of an efficient ventilating system.

Thirty cubic feet of air per occupant per minute, as specified above, as the standard of air supply for church ventilation is found in practice to be the minimum which will maintain satisfactory air movement and then only when properly diffused or distributed.

Brief reference only need be made to the subject of natural, or window, ventilation, for few of even its strongest advocates would consider its application to auditoria. The windows cannot be opened without serious inconvenience to those sitting nearby, this being especially true in severe weather. It is impossible to maintain the temperature in an auditorium uniformly with open windows, and a proper diffusion of the entering air is impossible. Even clear story windows are subject to the same objections, for the cold air most frequently falls in very objectionable drafts on those sitting in the pews. In warm weather, when drafts and breezes are welcome, the windows should be freely used.

The ideal church heating and ventilating system should be so designed as to entirely separate the heating and ventilating functions of the system. While this is generally advocated by ventilation authorities it seems especially desirable in church ventilation.

The church presents very large areas of walls and windows, and large entrance doors, the cooling effect of which is great. The high walls and large expanse of roof usually found in church buildings are sufficient to cool large volumes of air which frequently will, unless proper care is exercised in the design of the heating system, fall upon the audience as cold drafts. This should be prevented by means of a heating system so designed, and with units so spaced and located as to balance the cooling effect of walls, windows, roofs and doors. Peferably this should be accomplished by means of direct radiators, exposed, if possible, or they may be concealed in pockets if the same are properly designed. These radiators should be placed along the exterior walls, under the windows and near the doors.

A large amount of radiation should be placed in the entrance vestibules so that the air coming in through the doors will be properly warmed before reaching the auditorium. Otherwise most annoying drafts will be experienced by those sitting near the doors.

It has already been shown that the heating effect of the occupants of the auditorium is very large. To overcome this a ventilating system must very often become a cooling system. This can only be realized if the heating and ventilating system is so designed that the heating and ventilating elements thereof may act separately, the heating system to balance the heat losses through walls, windows, roof and doors, while the ventilating system provides fresh air for ventilation which shall be cool enough to overcome the heating effect of the audience.

In making the above statement the author would not have it inferred that the design of a successful all indirect heating and ventilating system is not possible, but rather that such a system, properly designed, involves additional complications in installation and operation and also additional expense in both, while giving less satisfactory results in operation.

The use of direct radiation also is desirable for preheating purposes and for warming the building when a small amount of heat only is required for a few people. Direct radiation is especially desirable in vestibules and small rooms.

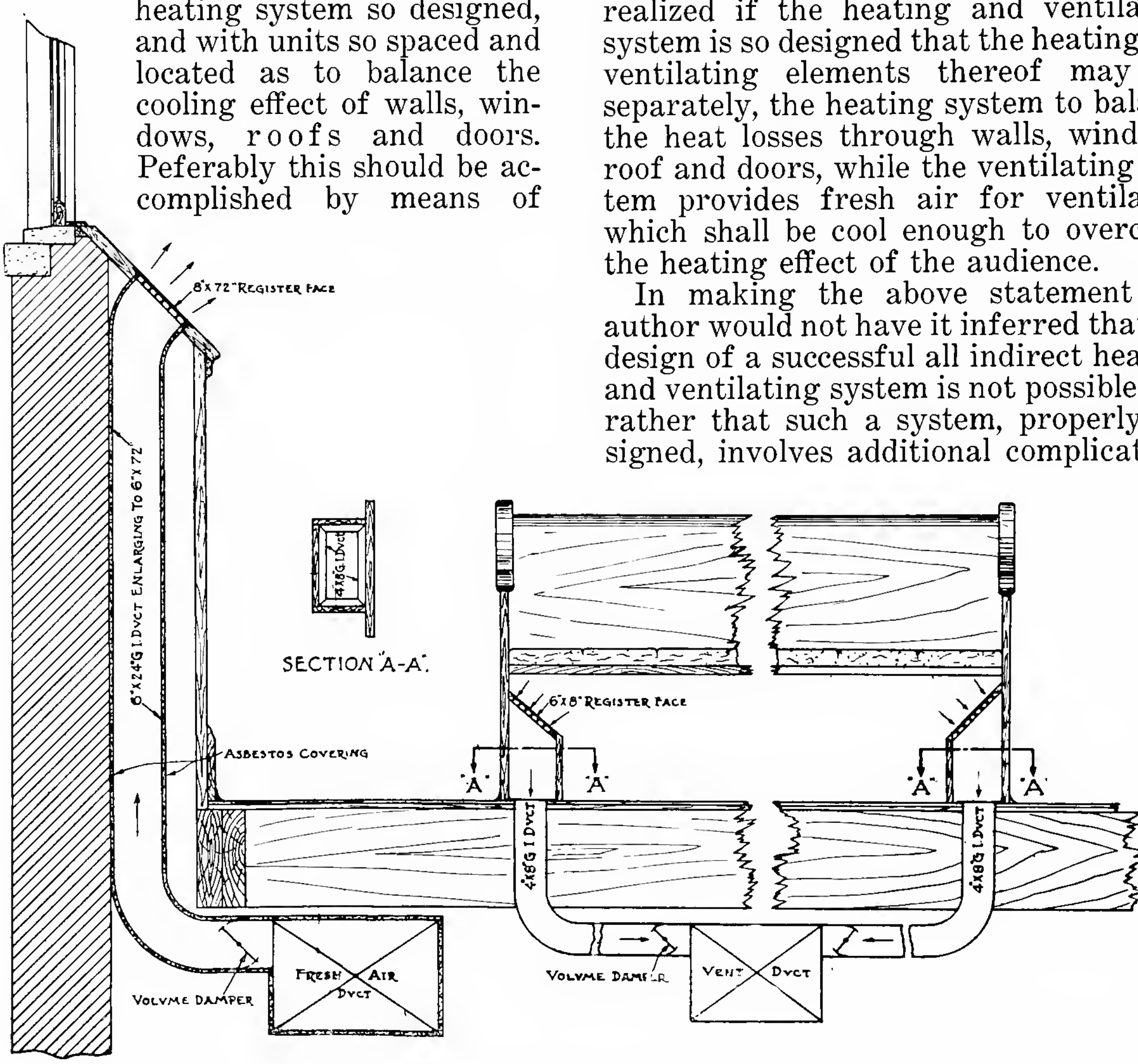


DIAGRAM SHOWING ARRANGEMENT OF FRESH AIR AND VENT OPENINGS FOR CHURCH VENTILATION

In small churches, seating, say, not over two hundred or even three hundred people, a gravity system of heating and ventilating, properly designed, will give very efficient results, but for larger buildings a fan system will operate much more effectively and at less expense. In a gravity system a considerable amount of heat is necessary to maintain the efficiency of the exhaust system, this heat being applied through the medium of accelerating radiators in the vent flues. The heat so applied to this exhausted air goes directly out of the building. A simple mathematical calculation will demonstrate that the amount of energy so applied will cost approximately ten times as much as the electric current necessary to move the same amount of air by means of an electric motor-driven fan, this calculation being based on the usual rate of five cents per kilowatt hour for electric current used for power.

In designing a gravity system of ventilation it is customary to base all calculations on an assumed difference in temperature of forty degrees between the room temperature and the outside temperature, that is, assuming sixty-six degrees as the room temperature, calculations are based on an assumed outside temperature of twenty-six degrees. Under this condition only will exactly the amount of air determined upon be supplied by the gravity supply system or be exhausted by the gravity exhaust system. And even this is largely affected by wind velocity and direction. When the outside temperature is lower a greater amount of air will be supplied and exhausted and when the outside temperature is higher a less amount of air will be supplied and exhausted. Inasmuch as the average outside temperature is higher than twenty-six degrees a less amount of air than determined upon will be exhausted for the major portion of the heating season. This is especially serious in view of the fact that ventilation is most needed in mild weather or when the outside temperature is from forty to sixty degrees. At such times the gravity ventilating system fails signally to give the results desired.

For auditoria of medium size a gravity system of fresh air supply combined with a fan system of air exhaust will give fairly satisfactory results.

For large auditoria both the fresh air supply and the vitiated air exhaust should be assured by the use of fans operated by electric motors.

The engineer is constantly asked if a system which supplies fresh air without regard to its exhaust, or which exhausts the vitiated air without regard to a fresh air supply, will not be a satisfactory system of ventilation. While it may not be disputed that either a fresh air supply system or an exhaust system will benefit the atmospheric conditions of an auditorium it may be positively stated that neither will give good ventilation to the room or will eliminate complaints. Only a proper combination of a fresh air supply system and vitiated air exhaust system will assure good ventilation in an auditorium.

The distribution or diffusion of the air used for ventilation has already been emphasized. To bring this about the thorough distribution of both the fresh air and vent openings is most essential. There should be multiple air inlets and exhaust openings in every auditorium. The mechanical conditions incident to the air entering from a fresh air register and the air leaving through the vent register are essentially different. In the case of the former the air comes in with a velocity which propels it straight on into the room, for which reason the fresh air openings must be so placed that the air emerging therefrom will not strike any of the occupants of the room, or the number, size and location of such fresh air openings must be so arranged that the velocity of the air or the volume of the air currents will not be such as to cause any inconvenience to those occupying the room. In case of the vent openings the drawing effect of the exhaust system is such that it can be felt a very short distance only from the register opening. Thus if these openings are not made too large and are sufficiently distributed they may be placed in closer proximity to the occupants of the room than is possible in the case of the fresh air openings.

The author believes that the following is a safe rule: No occupant of the room should be farther than twenty-five feet from a fresh air register or nearer than six feet to a vent register, and that there should be not less than one fresh air and one vent opening to each thirty occupants of the room. Insofar as the number of fresh air and vent openings are increased and generally distributed the satisfaction obtained from the operation of the ventilating system will be increased. In many cases some members of the audience must be more than twenty-five feet from the fresh air openings but a proper distribution of the fresh air openings (if in the walls) and an increased number of vent openings generally distributed over the floor of the auditorium will overcome this difficulty.

The greater number of complaints in church ventilation occur at points under galleries. Therefore special attention should be given to the proper ventilation of that portion of the auditorium under the galleries. Also the gallery space should be given proper consideration in the design of the ventilating system, and the pulpit platform and choir gallery should not be neglected.

Registers for either fresh air or vent, especially the former, directly in the floor should be avoided wherever possible.

Church auditoria, because of their construction, are not as well adapted to the usual downward or upward current ventilating system as are theatres where there are available large plenum and exhaust chambers below and above the auditorium. However, such systems may be approximated in churches by introducing the fresh air at a considerable number of well distributed fresh air openings in the walls or window sills and exhausting the air through a large number of openings under the pews. It is believed that this method is better than the reverse method because of the fact that the entering air must frequently be admitted at ten to fifteen degrees less than room temperature. This means that if sixty-six degrees is desired in the auditorium the entering air will possess a temperature of from fifty-one to fifty-six degrees. Air at this low temperature cannot be admitted directly in the vicinity of the occupants of the room without causing serious chilling and discomfort. It can, however, be admitted in the manner described without causing any such discomfort, for the air will enter well above the heads of the audience and gradually take up the heat increment, thus being warmed to a proper temperature before striking the occupants of the room. Such systems have been installed in a great many cases and have given most satisfactory results.

In case an auditorium must be used in warm weather when heating is not required and only ventilation and cooling is essential, there then being no danger of chilling the occupants of the room with the entering air, splendid results in the ventilating and cooling of the auditorium have been accomplished by so designing the ventilating plant that both fans can be made to blow air into the auditorium, this being accomplished by the simple shifting of one damper in the exhaust system. In this case the air is allowed to make its exit through doors and windows. This applies to warm weather ventilation only. As an auxiliary to the above plan a simple installation in the roof space, where such exists, of an electrically driven exhaust fan of the disc type of sufficient capacity to exhaust an amount of air equal to that supplied by both fans, when both are blowing in air, will assure the quickest possible removal of the hot air and the best possible ventilation of the room.

The use of both fans for blowing air into the room is possible only when the exhaust air openings are so distributed and placed that the air, when entering the room, will not directly strike any of the audience.

Simplicity of design is especially to be commended. While it is desired that this should be extended to all of the details of the system it applies with less force to the duct system, inasmuch as there is nothing about this which at any time requires the attention of the operator. Simplicity should be especially evidenced in the arrangement of the heating plant and that portion of the ventilating plant which includes the air filters, indirect heating elements, fans, motors and the operating devices therefor. The character of the janitorial service usually applied to such plants is far from that which would be economical to the owners, and therefore the element of simplicity has all the greater importance.

Such matters as organic content, or crowd poison, in the air, aerial infection, odors, ozone and dust need be referred to but briefly. The consensus of opinion is that there is no organic matter or crowd poison in the air of occupied spaces which has any serious bearing on health, and that aerial infection is probably impossible, or in any case it is not materially affected by ventilation. The use of ozone as a substitute for, or even an aid to ventilation, in other than industrial work, is no longer urged by the strongest advocate of the use of ozone.

Dust is no longer regarded as constituting a physiological menace but should be eliminated because of its annoyance and because of its disastrous effect on the decorations, finish and furnishings of the church. It certainly does not exist in the air of the church in harmful quantities. It is claimed by some, however, that dust coming in contact with the steam heating surface distills ammonia and absorbs some oxygen, and although this is far from being proven there certainly can be no dispute that every possible effort should be made to eliminate the dust.

Odors, such as are always given off from the mouths, bodies and clothing, will always occur in a densely occupied apartment lacking proper ventilation. They are certainly objectionable and, even though it may be agreed that they have no physiological significance, our sense of decency should impel us to provide that degree of ventilation which will dilute the air to such an extent that disagreeable odors cannot exist.

It is not proposed in this article to discuss in detail the apparatus used in church heating and ventilating systems but a few general statements anent governing principles will be offered.

It is unfortunate that in a majority of cases the boiler room must be placed directly under the auditorium. It is desirable that the boiler room be placed in an isolated position so that the noise and dirt connected therewith may be kept from the principal rooms of the building.

Whenever possible the coal room should be made large enough to hold a season's supply of fuel as this enables the purchasing of fuel at the season when coal is at its lowest price. This room should be so arranged that all of this coal may be put in without basketing, trimming or rehandling.

One of the most prolific sources of difficulty in church heating and ventilating systems is the chimney. Frequently it is insufficient in cross-sectional area and more frequently it is insufficient in height. Instances are frequently found where the top of the chimney is below portions of the roof with the result that the draft is insufficient and down-drafts are common. The logical and usual result of this is that the boilers operate inefficiently and fail to give the capacity required, while gas in large quantities is frequently blown from the furnaces into the building. The top of the chimney should invariably exceed, by not less than two feet, the highest portion of the roof of the building.

A steam heating system will be found most satisfactory for church purposes. Hot water is rarely used and is objectionable because of the danger of freezing when the building is not kept warm in cold weather. It is also slow in warming up and equally slow in cooling off in case the building becomes overheated. Furnaces are adaptable to small churches only. They are impractical from a ventilating standpoint in large buildings.

As has already been urged, direct radiators should be used to an extent which will balance the heat losses through walls, windows, doors and roof, but in determining the amount of direct radiation it is not desirable to take into account the air within the room. This should be taken into account in the design of the ventilating system. The direct radiators may be concealed in pockets if desired, but as a rule inconspicuous locations can be found for exposed radiators. When concealed the amount of radiation must be increased by twenty to forty per cent., depending upon the method adopted in constructing the pockets, and the register area over the radiators. The registers may cover the entire face of the radiators or they may be arranged with one register face at or below the bottom of the radiator and another register face with the bottom thereof at the top or above the top of the radiator. The minimum height of the pocket should be such that there would be a space below and above the radiator equal to the depth of the pocket. Sufficient space should be allowed at the ends of the radiator for connections and valves with easy access to the valves provided.

Special care should be given to the placing of radiators in the vestibule, these radiators being from two to three times as large as is required for the actual warming of the vestibule when the doors are closed.

By reference to the plans of the small church illustrated herein, it will be noted that access from the front door into the auditorium is gained only by passing from the outer to an inner vestibule and thence into the church. Such an arrangement provides for the heating of such air as may blow in and prevents a direct draft on those sitting in the rear of the auditorium.

Uses are frequently made of registers in the ceiling connecting with ventilators on the roof as a means of heat relief. As a means of ventilation they are of no value whatever inasmuch as they have no effect on the air of the occupied portion of the auditorium. Worse still, they are very objectionable because cold air will often blow down through these ceiling registers into the auditorium, forming most annoying drafts on those sitting below. If installed, means must be provided for shutting off when necessary, and without fans in connection therewith, they require extreme good judgment on the part of the janitor in their use.

The use of an automatic temperature controlling system for church heating is strongly advocated. Manual control of temperature in an auditorium is practically impossible. The temperature of the room increases very rapidly after it becomes occupied and but little opportunity is offered the janitor to get at the radiators and shut them off. Automatic means of temperature control should be separately applied to the direct radiators that the direct heat may be maintained only in so far as the cooling effect of walls, windows, doors and roof require, and it should also be applied separately to the ventilating system so that the temperature of the ventilating air may be maintained at just the proper point to maintain a proper room temperature while removing the heat accumulation.

Some method of air filtration should be provided in large buildings where large volumes of air are handled, to eliminate the dust from the entering air. This may be well done by the use of cloth filtering screens of either the "bag" type or the "zig-zag" type, or it may be more efficiently done by the use of air washers. These air washers need not have the humidifying attachments inasmuch as artificial humidification is not necessary. The air washers are more efficient in air cleaning and are less troublesome to keep clean and efficient. An air washer, designed for the purpose, may also prove a desirable adjunct in the cooling work of the ventilating system in warm weather.

The piping system should be as simple as possible, but extreme care must be taken to secure ample size and pitch of pipes and place them at proper levels so that there will be no occurrence of "snapping" or other noise. These steam pipes should be thoroughly covered with asbestos or magnesia insulating coverings of the best make to economize in the operation of the plant and to prevent heating where and when not desired in basement rooms. The two pipe system is preferable for church buildings.

Air valves, where used, should be of the drip line pattern with drip piping carried to a sink or other convenient point in the basement, or better still to an air removing pump. The float type valve without the drip pipe should never be used as altogether too frequently these valves will give trouble during church service by causing a sputtering of water or a hissing of steam.

Plans of two church buildings are illustrated herewith. Plan number one is that of the First Presbyterian Church at Buffalo, N. Y. (see page 20), the main floor plan only being presented. The building was built many years ago and this ventilating system was installed two years ago. This plan is shown to illustrate the point made above relating to the distribution of the fresh air and vent registers. As will be noted the air is supplied to the main auditorium through twenty-six inlet sources and it is exhausted at ninety-three points. If this system were designed for a new building the fresh air registers would not have been placed in the floor and the number of vent registers would have been increased so as to give a greater distribution of the air.

The fresh air is furnished by means of a fan system incorporated into which are air filters, heating coils, distributing ducts, etc.

Plan number two is given to illustrate the possibilities of installing an inexpensive but efficient ventilating system in a small church. Inasmuch as funds were not available for an ideal system certain existing conditions within the building have been utilized and resort has been had to the bringing in of the fresh air through inlets under the pews, the three-foot space under the auditorium floor being used as a plenum chamber. As will be observed (see plans, pages 21 and 22, and sections, page 23), the air is exhausted at the front and rear of the auditorium. A thorough diffusion of the air throughout all of the occupied portion of the room is assured.

In this case it has been arranged to use the same system interchangeably for the Sunday School building. As will be noted, this is very simply done in this case, a single chain pull being used to accomplish this change.

As a rule such a double use of an apparatus should be avoided. It can seldom be done with as little complication as is involved in this case. The amount of complication usually involved seriously limits the efficiency of the system for one or another portion of the building, and carelessness on the part of the janitor is all that is additionally needed to render the plant inefficient for one room or the other, and sometimes for both.

An illustration is given of a method of bringing the air in through the window sill of a church so that it will become distributed over the heads of the audience and drawing it out through the multiple openings in the floor, as shown. As will be noted the vent openings are above the floor level so that the floor sweepings can not fall down into the openings, and overcoats or hats may not be laid over the openings. This arrangement also prevents the moving air from coming into direct contact with the feet of the occupants of the room. Where the room below the auditorium is not used and the space is without openings the collecting ducts shown in the detail sketch may be omitted and the space under the floor can then be used as an exhaust chamber.

The engineer is frequently asked how much a ventilating system for a certain church building will cost before a design of the system is attempted. The author has collected data on twelve churches to determine whether a unit method of estimating the cost of a ventilating system can be found. The method of apportioning a certain percentage of the total cost of the structure is of little value in any building but especially so in the case of a church inasmuch as the heating and ventilating system would cost substantially the same whether the building were a frame structure or a monumental stone structure, so long as its size and shape were approximately the same.

In the churches referred to this percentage of cost varies from 3.3% to 9.4%. On the basis of the cubic feet of occupied space, this calculation including only the interior space and neglecting the space within the towers, lanterns, unused attic spaces, etc., the heating and ventilating system is found to cost from one cent to two and one-half cents per cubic foot. Manifestly a church having a very high auditorium has a lower cost per cubic foot. For a simple system of ventilation in the average church one and one-half cents per cubic foot should provide for a good ventilating system. Where the system is complicated or the construction or arrangement of the building involves complication this figure should be raised to two and one-half cents per cubic foot. The experience and judgment of the consulting engineer should enable him to set this figure with reasonable accuracy.

On the basis of the number of occupants provided for in the main auditorium and in the main room of the Sunday School building, a heating and ventilating system will be found to cost from $2.70 per occupant to $5.50 per occupant. A fair average will be found to be from $3.25 to $3.50 per occupant, this figure being raised or lowered in proportion to the nature and arrangement of the building and the resulting complication of the heating and ventilating system.

The table also gives data on the operating costs of heating and ventilating plants actually installed and operated. It is not possible to separate the cost of electric current used for lighting and power, both being measured on the same meters in most cases.

The design of a heating and ventilating system for a church building has been regarded as a very simple matter. The difficulties of this work have not been appreciated and the result has been that this work has been left to inexperienced parties. It is not surprising, therefore, that a great many failures have resulted and that a great deal of criticism has been directed against the ventilation of church buildings. Such work should be left to experienced engineers who will undertake the problem without preconceived ideas or prejudices, or without the influence of an interest in any materials, apparatus or "system." Many failures have resulted from the advocacy of certain "systems," which the manufacturer has endeavored to apply to all types of buildings, regardless of conditions or actual needs of the building.

Another cause for many failures in ventilating systems is the desire of too many committees, and of too many architects also, to build a beautiful building, using all of the appropriation for space or ornamental features, forgetting that the extent of the enjoyment to be had in the use of the building is very largely in proportion to the comfort and pleasure found in its occupancy. There is nothing which contributes more to this pleasure and comfort than a proper heating and ventilating system. The logical results of a cheaply installed ventilating system are dissatisfaction and the ultimate removal of the system.

Mention may be made of an instance in which a church seating six hundred persons installed a ventilating system costing $400.00. The only possible result of such an installation was dissatisfaction and abandonment. This system is now being removed and a ventilating system costing $3,000.00 is being added to the existing heating system, the need of an efficient ventilating system being realized.

In another case the church first installed a furnace system. This was removed and a cheap steam heating and ventilating system was installed, the ventilating features of which were later removed. After two years' experience with the resulting system it has been decided to install an efficient ventilating system at a cost of $8,800.00, or approximately the cost of the two systems previously installed and abandoned.

The experiences above referred to, and others, have demonstrated beyond dispute that an auditorium without a ventilating system will give discomfort to the audience and produce headaches, depression, lassitude, somnolence, and even dizziness and nausea. Conversely, the operation of the efficient ventilating system replaces the uninterested, dull and inattentive audience with a comfortable, alert and attentive audience, having receptive, responsive and retentive minds, thus experiencing increased profit and enjoyment of the building and of the services therein.

The investigations of the New York State Ventilation Commission have demonstrated positively that uncomfortable atmospheric conditions noticeably and materially lessen the interest and alertness of the individual.

Assuredly churches are built not alone as monuments of architecture but for the enjoyment and profit of the people. Therefore should not the ventilating system, which has so much to do with the health, comfort, pleasure and profit of the church attendants, receive at least equal consideration with the stained glass windows, organ and architectural features of the building?

CHURCH VENTILATION—BY D. D. KIMBALL

COST DATA

Name and Location of Church	Year Built	Exterior Con-struc-tion	Cubic Feet in Building	Total Cost of Contracts			Percentage Contracts Bear to Total Cost			Cost per Cubic Foot			Annual Cost			Annual Cost per Cubic Foot		
				Building	Heating and Venti-lating Plant	Elec-tric Sys-tem	Build-ing	Heating and Venti-lating Plant	Elec-tric Sys-tem	Build-ing	Heating and Venti-lating Plant	Elec-tric Sys-tem	Fuel	Elec-tricity	Boiler Room and Janitor Service	Fuel	Elec-tricity	Boiler Room and Janitor Service
Newton Highlands Congregational Church, Newton Highlands, Mass.	1905	Stone	306,160	$62,924	$2,630	$590	% 94.8	% 4.2	% 1	$.205	$.0086	$ 0019	$424 35	$100.4	$500	$.0014	$.0003	$.0016
First Baptist Church, Chelsea, Mass.	1908	Stone	310,000	58,128	4,000	875	91 6	6 9	1.5	19	013	0026	303 50	176 39	600	0009	.0006	0019
Central Congregational Church, Chelsea, Mass.	1909	Stone	208,470	53,413	3,589	848	91.7	6 7	1.6	.256	017	.004	323 00	98 00	520	0015	.0004	.002
First Parish Universalist Church, Malden, Mass.	1907	Stone	341,168	66,360	4,085	1000	92.3	6 2	1.5	.194	.012	.003	508 00	135 60	600	0015	.0004	0018
First Congregational Church, Stamford, Conn.	1911	Stone	300,840	57,897	3,284	...	94 3	5 7	...	.192	.011	......	350.00	75.00	600	0012	0002	002
First Parish Church, Braintree, Mass.	1912	Stone	205,709	41,220	3,300	500	90.7	8 1	1.2	20	.016	.003	300 00	46 00	400	.0014	.0002	.0019
Melrose First Baptist Church, Melrose, Mass.	1906	Stone	315,000	65,607	4,249	1027	92	6 5	1.5	.208	.0135	003	265.00	150.00	600	0008	.0005	.0019
Church of the Ascension, New York City	1913	Brick	170,260	44,503 50	4,200	....	90.6	9.4	.	261	.025	...	.....	.	.....		...	...
First Baptist Church, Montclair, N. J.	1911	Stone	475,240	79,066	5,662	775	91.9	7.1	1.	.17	.012	.0016	332.00	100 00	900	0008	0002	002
St. Joseph's Cathedral, Buffalo, N. Y.	1912-14	Marble	3,120,000	1,200,000	39,075	.	96 7	3.3	.....	.383	.012	..	.	...	.	.	.	.
Unitarian Church, Leominster, Mass.	1903	Stone	301,200	51,713	2,795	660	93.3	5.4	1.3	.171	01	0022	...	...	...	......	...	.
North Presbyterian Church, Buffalo, N. Y.	1904	Stone	524,000	139,700	9,451	1200	92.2	6.8	1	266	018	.0023	.	....	..	...		....

SEE PRECEDING PAGES FOR REFERENCE.

BETHLEHEM CHAPEL—CATHEDRAL OF SS. PETER AND PAUL, WASHINGTON, D. C.

HOMELY REMARKS ON CHURCH FITMENTS

By ROBERT ELLIS JONES, S. T. D., Canon of the Cathedral of St. John the Divine

THE legislative rule that the contents of a bill must not go beyond the implications of its title cannot be extended to an article like this. Questions of structure *will* intrude themselves upon it. It is enough to disclaim any intention to dogmatize upon purely architectural matters, or to do anything more than to give the results of the writer's observation of church utilities.

The article also confines itself to ecclesiastical fitments, to those things that pertain distinctively to churches, the obvious utilities necessary to any public building will be taken for granted, and the complex arrangements of a parish house will not be touched upon at all, the domestic needs of parishes differ widely, and provision for them is germane to secular work.

It may save many qualifications to say that a good sized town church, one holding from six to eight hundred, is chiefly held in mind. Cathedrals will always be few, churches holding twelve hundred people not common, and the village church, interesting as it is, full of picturesque possibilities, ought not to be built unless special circumstances make it certain that the luxury can be afforded—and maintained. No church should be built that cannot under normal circumstances maintain its fixed charges. Most "lovely little churches" must starve their parson. A church should be large enough to make the per capita fixed charge for maintenance moderate and easily carried. The fixed charges for clerical salaries, music, sexton, in two churches holding four hundred and seven hundred respectively are substantially the same. The only appreciable difference is in the cost of heating and lighting. The size of church dictated by a rational economy is large enough to allow of considerable architectural dignity, and this article will refrain from darting from minister to chapel and confine itself to the average town church holding from six to eight hundred.

Approaches — Churches should be placed as low as possible in order to reduce the number of the entrance steps. An unbroken run of ten or a dozen front steps is unfortunate and dangerous. Such a run is inconvenient for old or infirm persons, almost impossible at funerals when heavy caskets have to be carried in, and in winter liable to be icy, menacing old and young, living and dead, with entire impartiality. When a long run is unavoidable, it should be broken by broad platforms. The usual reason for raising the floor level is the desire to provide well lighted Sunday School rooms and vestries in the basement. Nothing is more fatal to a Sunday School. I have seen basements upon which money had been lavished without stint in the effort to prove that a Sunday School *can* thrive below ground, but all alike were failures, and are today replaced by parish houses. Choir vestries are more at home in basements, but they are usually connected with the church above by narrow passages and winding stairs, almost always too steep. It is ample proof that the average choir-boy has not "a one-track mind," that he can manage the unaccustomed skirt of his cassock, sing "Onward, Christian Soldiers!" and negotiate narrow "winders" all at the same time. It is unwise to purchase the doubtful advantages of high basements at the cost of inconvenience and danger to a multitude of worshippers.

Vestibules — Western vestibules, either structural or obtained by the use of screens at the end of the nave, are absolutely necessary. A western gallery, roofing a screened narthex, is useful for many purposes. It may be said in passing that this is the only position where a gallery is either useful or tolerable. Funeral and wedding parties need a place where they may form and wait in privacy. This seclusion should be possible without stopping the entrance of the congregation. Such a narthex can be entered directly by the central door of the nave, leaving the aisle doors for the ingress of the people.

A signal from the west door should be provided to forestall the excited rush of the verger between the vestibule and the clergy room when all is ready.

The Font — The font is many times placed near the west door or in one of the aisles near its western end. This is symbolically correct. The entrances to the church below and the church above are kept together. But practically it is wrong. A western position is seldom a good one. At the majority of the services the people turn their backs upon the font and it is forgotten. A special chamber, alcove, or other position indicated by structure or decoration, near the chancel is preferable. The font if raised should have at the level of the highest step a platform two feet by three upon which the priest can stand securely while performing the baptism. This standing place should be upon the right side of the font so as to bring the child near the bowl on the priest's left as he stands facing west. The effort to stand upon a narrow step is as distracting to the officiant as it is dangerous to the child. A small book rest should be provided near by upon which to place the prayer book during the act of baptism. Often there is no place to rest the book except the margin of the font, where it as well as the child is affused.

A font may easily be too monumental, making it difficult to reach over into its capacious depths to obtain the little water needed. Low prayer desks for the parents and sponsors are of great convenience. When not in use they may serve to give the font a reverent protection. A drain must of course be provided. The bowl should be waterproofed in some suitable way. Otherwise dust and grime adhere to the damp stone.

Seating — Practice as to the seating of churches is drifting from pews to chairs, with favorable results. One of the best is that a chair defeats selfish efforts to occupy three sittings at once, and another advantage is that upon occasion readjustments to suit the circumstances can easily be made. It is sometimes desirable to make the middle aisle wider than usual, as at funerals or at functions employing a numerous procession. A useful average width for a middle aisle is five feet, though this is sometimes scanty, when a casket with bearers on each side must be provided for. The tendency of chairs to fall into irregularity and disorder can be overcome by connecting groups of three or four by means of a strip of wood under the seat. In this way sufficient elbow room for each person can be assured. Twenty-two inches per person is the least comfortable allowance. The eighteen-inch allotment used by architects trying to show a grasping committee how much they are getting at a low cost is misleading. In this detail both parties seem to be "given over to strong delusion that they should believe a lie."

The spacing of the rows is important. They must be sufficiently distant to allow of comfortable kneeling, for which fully thirty-six inches is required. Where kneeling is not practiced thirty inches may suffice. In the liturgical churches a spacing of thirty-three inches is very common, but it is not enough, since kneeling becomes a process of wedging oneself into too snug a space. A kneeler hinged to a chair in front of the worshipper seldom projects backward sufficiently to permit an ordinarily stout adult to use it. A loose pad of felt that can be placed in any position is by far the best kneeler. Two inches is the least thickness, but four inches is much better. Kneeling is apparently a disused exercise—impossible unless all the accessories favor and assist it. It must be possible for each person to put his feet under his own chair. Church chairs are often provided with slats or racks underneath the seats to receive hats or kneeling pads when not in use. If these racks have the full depth of the seat the chairs must be spaced three feet six inches apart or kneeling is penalized. A rack half the depth of the seat serves all purposes. Pockets for prayer books, etc., should be attached to the backs of the chairs. The chair back should be capped with a flat rail to serve the worshipper's convenience. The chair should be of good size, strong and comfortably proportioned. The rush bottomed church chair of the European pattern is frail and uncomfortable—quite inadequate for a stout person. It is difficult but not impossible to find a well-designed ready-made church chair, but any good architect can design one.

The Pulpit—Conditions vary so widely that little can be said dogmatically about pulpits. Often they are made inconveniently deep and narrow, so that the preacher seems immersed in their tub-like depths, confirming Daniel Webster's opinion that its survival after centuries of proclamation from tub pulpits is ample proof of the truth of the Gospel. In a monumental pulpit the enclosing front must be high relatively to the speaker's stature. but the average parish church is not large enough to call for a monumental structure. The indication is for a pulpit of such moderate scale that its front may be quite low, so that the preacher cannot reach or grasp it with his hands to pound upon it, or to swing his body backward and forward from its anchorage, from sheer nervousness apropos of nothing. An eminent authority recommends a high pulpit as preventing a nervous "dangling" of the hands. There is no arrangement certain to defeat the eccentric motions of the clergy. It is perhaps a choice between "dangling" and "see-sawing." The manuscript desk should be adjustable as to height and slope and should carry a concealed light. Sounding boards are a sore subject. No sounding board has ever been made which is at once architecturally beautiful and acoustically successful. The only counsel is to get along without one if possible.

The Lectern — The lectern should comply not only with the scale of the church, but with its acoustical requirements and should have regard to the limitations of human stature. A distinguished architect whose beautiful lectern was impossibly high refused to allow the use of a reader's platform behind it. The reader must be lifted above the book desk to a height that shall allow his face to be seen, for two reasons. First, we depend upon play of feature as well as upon hearing for a full understanding of the spoken word. We would not tolerate an invisible preacher, much less should we endure an invisible reader of the Word of God. Next, the reader's voice must not be blocked or deflected. It must have free diffusion if it is to "carry" any distance. It is significant that in the churches of the Protestant denominations which are not under the influence of tradition, the monumental, all-concealing lectern is unknown, while the reading of the Scriptures reaches a high degree of excellence. The most efficient obstacle to reach of tone is the tall double lectern of the monastic music-desk type, yielding two sides pitched at an angle of forty-five degrees, carrying the Old Testament on one side and the New Testament on the other. These desks were intended to serve a number of singers standing around them looking upward to the steep-sloped pages of the illuminated Psalter. Obviously the practicable lectern will have but a moderate slope. Otherwise the top and bottom of the page cannot be read with the same eye focus.

Choir Stalls — Choir stalls should conform to utilitarian requirements as to the height of the book desks, the depth of the seats, slope of the backs and the kneelers. Ornamentation should not be allowed to interfere with these primary requirements. The convenience of the singers contributes immensely to the reposefulness and reverence of the service. To over-emphasize the stalls detracts from the dignity of the altar. Elaborate carving may well be confined to the canopies of the back row of stalls. It is a matter of congratulation that the best current work shows a disuse of the fussy poppy-heads that a little while ago were thought to be essential. Modern Gothic is now less spiky than it used to be. The proper height for the book desks is that which brings the books to a convenient height when the choir is kneeling. It is very difficult to strike a successful average between a kneeling and a standing height. The requirements of kneeling should rule; in standing the book may be held in the hand. It is a very awkward mistake to give the book desk an acute pitch. It should be rather flat, rising about three inches in its twelve inches of width. One of the main purposes of the book desk is to hold in readiness and in plain sight the music next to be used, quite impossible with a high-pitched desk. Ample pockets should be provided below the desks. The number of books used by a choir in the course of a service is not imagined by most people. A place for everything is the price of order and reverence.

In the interests of scale, choir stalls are often made too low and small—mere pews, overlooking one of the main purposes of choir stalls—partially to conceal the choristers, (the very reverse of the principle obtaining as to the pulpit) making their necessary movements unobtrusive. Rows of heads and shoulders should be seen—not the figure from the hips up. The rule holds for choir and clergy that when the desks at which they kneel are low enough to support their elbows they are too low. Such desks put a premium on undignified "hunching."

The Organ and Console — Little need be said about the organ except that it should not be smothered in a scanty chamber from which it cannot speak out. With a given number of stops the best result obtains when the pipes have ample space above and around them for the diffusion of sound. To lose a third of the effectiveness of an expensive instrument by smothering it is not intelligent procedure. Usually the organ builder is not consulted until the organ coop is finished.

The console should not be placed in the choir proper. It is a part of the machinery. It is a principle that the mechanism of worship should be concealed. The console is often incorporated in the stallwork or placed on the presbytery (i. e. the space between the choir stalls and the chancel rail), where it sometimes vies with the altar in size and prominence. These positions are assigned in the interests of the contiguity of choir and organist, and to allow the latter to "conduct," that is, to wave one hand above his head while playing with his other members, and swaying all over, to the utter destruction of devotional repose. Any musical advantage that defeats religious impressiveness must be sacrificed. Many chancels are so circumscribed that it is difficult to comply with ideal requirements, but if the latter are held in mind during the planning of a church they can usually be met. The console can be located in a chamber behind the singers, or in a gallery above their heads. The use of mirrors solves many problems. In the new St. Thomas Church both contiguity and concealment have been secured. Unaccompanied singing *does* require "conducting." In such cases the organist should take place as a member of the choir and guide it as quietly as may be.

The Presbytery — By "presbytery" is meant the space, usually elevated above the choir floor, between the choir stalls and the chancel rail. In English cathedrals the presbytery sometimes extends two or three bays, but in our churches it is contracted and disappears as a separate division. It was anciently occupied by the clergy not actively engaged in the service. Now it is important as the space wherein the laity approach the the chancel rails during celebrations, where wedding parties stand and where confirmation and ordination are administered. Space and convenience are obviously demanded. Yet there is no part of the church so completely unconsidered. It frequently happens that barely three feet intervene between the choir stalls and the chancel rail. Communicants approach, divide and fill the rail to its ends, then return to the centre and plow through the waiting crowd while another set files into the pockets. The level space of the presbytery should be wide enough for one row of people to kneel and for another row to stand behind them, or, to put it otherwise, wide enough for kneeling and for passage. Six feet of clear space is sufficient. An architect exclaims, "That means six feet of foundations, walls, floor and roofing." It does, but the miserable confusion seen in most large churches on the first Sunday of the month should be decisive as to the wisdom of the expenditure. The presbytery should always be provided at the north and south ends with exits, either into the choir aisles or into passages otherwise arranged for, sometimes through the choir or clergy vestries. Central approach and terminal discharge are obvious requisites of order.

The Sanctuary — The sanctuary should be raised above the presbytery by not more than one step, upon which, with the intervention of a cushion, the people may kneel. There should not be a series of steps leading up to the level of the sanctuary. Kneeling upon the topmost of a flight of steps is an impossible performance for most people. The kneeler for the laity should always be at the same level as that in which the priest stands. To cause the people to kneel upon a step six inches lower than the sanctuary floor necessitates a wearying and awkward bending over during the administration of the sacrament.

Chancel rails are an utilitarian necessity and should not be emphasized. Some architects say they are needless, but clerical experience dissents. The laity, the old, stout and feeble, protest against their absence. The chancel rail should have that height which allows the chalice to be passed without danger to a short person kneeling on the other side of the rail. Twenty or twenty-two inches is a convenient height, though twenty-four inches is practicable if the people kneel on the priest's level. If they kneel six inches lower the twenty-four inches of the rail's height become thirty, and the passage of the chalice becomes impossible. For convenience in the administration of the elements chancel rails should also be narrow. The twelve-inch wide caps of the marble walls (quite too high) which some architects build across the sanctuary are immensely awkward. The communicants' kneeling desks, which are now displacing rails, are welcome innovations, provided they also be not made too high and broad.

The Altar — Since there is abundant guidance as to this central, all-important fitment, a few remarks about the altar will suffice. An extreme elevation of the altar is to be avoided, since many steps mean danger and inconvenience for feeble or dim-sighted clergymen. An altar not less than three feet three inches high is more convenient for the celebrant than a lower one. The foot pace upon which the priest stands should not be less than three feet wide. The altar, unless it be a small one in a chapel, should be set out from the east wall or reredos at least twenty inches to allow of reaching the ornaments on the retable without making the altar a mounting block.

The gratifying improvement in church architecture during the last twenty-five years can best be measured by an inspection of the volume containing the fifty or more competitive designs for the Cathedral of St. John the Divine. A few plans combined originality and scholarship, but most of them exhibited either wild eccentricity or lifeless correctness, while many were conceived in complete unconsciousness of the most elementary architectural canons; there were mosques and meeting-houses (with Anglican trimmings) but in nearly all alike the procedure of design must have been that of taking the architect's ideal of a parish church and inflating it to a cathedral size, with the usual disastrous results of awkwardness and poverty of detail; a more triumphant demonstration of "how not to do it" cannot be imagined. The collection, as a whole, was the work of untrained men, some of them obviously "unrepentant carpenters," their notions of cathedral scale and function would have been laughable had they not been tragic. The most prominent advocate of the cathedral movement confessed that he rose from his first inspection of the designs appalled, humiliated and convinced that the project had been launched too soon; neither the architects nor the public were prepared for it. The public's approval was enthusiastically bestowed upon a fantastic design as lacking in repose as in sound engineering. Profession, parsons and public were obviously wandering in a vain shadow.

Today no competition would be necessary; the project could be safely committed to any one of a number of architects, whose spirited and noble work adorns our land. It is not too much to say that we have some churches which would have been considered great in the thirteenth century. Nearly every layman holds some practitioner, usually the designer of his parish church, to be "the greatest church architect in America," and behind these masters there is an army of competent young men who are filling the land with excellent work. The Chicago man's prophecy, uttered a quarter of a century ago regarding his beloved city, could at that time have been applied to America at large and to its architectural capacity. The prophetic soul aforesaid, with proud humility, declared "Chicago hasn't reached culture yet, but when she does, she'll make it *hum*."

We are now safe in the hands of our architects, and are beginning not to direct them as jauntily as we did some years ago. The "cultivated amateur" is no longer the final arbiter and the parson's pride of practicality gives him authority only on such matters as the subjects of these "Remarks." He can only hope to contribute well defined utilitarian principles. Noble church building is the result of the fusion of artistry, engineering and utility; neither can be safely sacrificed; a successful church is one which is an outgrowth of the needs of worship. Nothing was more admirably and rigorously suited to its purposes than the mediæval cathedral to the requirements of Roman Catholic ritual. Gothic theory has to do with much more than pointed arches. *One of the fundamental canons was conformance to present needs.* The Gothic spirit demands that we discard tradition and precedent where they conflict with the needs of the present. It is only by endeavoring to meet those demands that our architecture will achieve that differentiation which results in vitality. We are all weary of assertions that this or that "is the only religious style," and are ill at ease in churches whose architecture is incongruous with the worship conducted therein and discordant with the traditions of the worshipping body. There is a true sense in which the Colonial meeting-house, occupied by non-liturgical congregations, is far more "Gothic" than the thirteenth century near-cathedral which sometimes replaces the meeting-house; any vital architecture is an outgrowth of the needs and personality of its builders; this correspondence of the inner and outer is perhaps the deepest Gothic principle of all. The American practitioner now combines ample knowledge of the past with a recognition of present needs, as artist, engineer and ecclesiologist he is a rapidly growing man. The future of our church architecture is full of hope and promise.

STALL ENDS, CALVARY CHURCH, PITTSBURGH, PA.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

MODERN METHODS OF CHURCH ILLUMINATION

By F. A. PATTISON, A.I.E.E., A.S.M.E., I.E.S.

THE artificial illumination of a church is a problem for which it is often very difficult to find a satisfactory solution. There are two elements which must be most carefully considered in connection with the lighting of any building, viz., the use for which the structure is erected and the Architect's motive in his design. These two considerations combine to create the atmosphere which at all hazard must be maintained. Any equipment which lacks the proper preservation and perpetuation of this atmosphere spells failure no matter how elaborate or exquisite in detail the various elements of the illumination may be. The lighting of a church must be sufficient to properly illuminate and if fixtures are used they must carry out the symbolism and never be obtrusive in the sense of introducing a jarring note either to the architecture or the comfort and mental attitude of the worshippers.

The earliest examples of the artificial illumination being introduced in harmony with the building are seen in the chandeliers often called crowns. In the Gothic churches these were made very elaborate and capable of providing for a great many candles. Perhaps the crowns of Aix-la-Chapelle, Hildesheim and Rheims are as typical of this early practice as any which could be cited. These were made in various metals and also in wood. All metals are still used and even at the present time, wood is sometimes used, as may be seen in the fixtures of the Broadway Tabernacle in New York City. The use of the candles in the earliest times had the advantage of a unit whose intrinsic brilliancy was very low and, therefore, could be used with much better effect than modern illuminants utilized in the same way. The largest crown was customarily hung from the arches of the nave and its size, decoration, and symbolism was the subject of much study. As a result it became an integral part of the edifice and fulfilled perfectly the function for which it was installed. Hence the satisfaction both visual and spiritual as there was harmony and the atmosphere to produce the proper effect. As time went on, the worshippers took more of a part in the services until at the present time it is necessary for them to be able to read. Therefore it is imperative to provide proper illumination to enable them to do this.

In the early days the candle was the only illuminant. This was followed by oil lamps and now we have gas and several types of electric lamps. The cleanliness, ease of locating at any desired point, capability of subdivision and shaping, and simplicity of control have led to the almost universal adoption of the electric light for modern church buildings. Even the candle tip in the altar candles is being replaced by the filament of the electric globe.

The variation in size, design, and character of buildings classified as churches, is such that it is not possible to describe details so as to apply to all. But in the illumination of the small country church, the pretentious city church, and the cathedral, regardless of the architecture, there are certain requirements common to all which can be complied with no matter how simply or elaborately the details are carried out. They all have an approach, exterior, entrances, space for congregation, chancel, choir, windows and rooms not in the church space proper. These are the parts which have to be lighted. The first consideration is the amount of light necessary to obtain proper illumination. If the public lights in the street do not give proper light, the approach should be illuminated with gas or incandescent lamps. It should not be brilliantly illuminated. One tenth foot candles is ample. There is no excuse for any lights on the exterior of the building except at the entrances, a carefully screened re-

ST. PAUL'S CATHEDRAL, DETROIT, MICH.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

(For additional illustrations of this subject see index)

flector for the bulletin board and possibly an illuminated cross on the steeple. Any bare lamps strung on the outside or over the doors not only detracts from the architecture but produces a disagreeable glare and therefore offends everyone entering the edifice.

Illumination is measured by the candle foot. This is the illumination produced on a surface one foot distant by a source of one candle power, the rays falling normally on the surface. The proper illumination, in the portion of the church enumerated above, is as follows in foot candles:

Entrances	.5
Congregation space	2–3
Choir	1–2
Chancel	2–3
Windows	5
General Rooms	1–2

In arriving at this result the light reflected by the various surfaces, such as ceiling, walls, etc., and the light which will be absorbed by the various shades must be given very careful consideration.

The percentage of light reflected from various surfaces with the authorities is as follows:

Black velvet (Sumptner)	0.4
Deep Chocolate (Sumptner)	4.0
Black paper (Rood & Tufts)	4.5
Dark Blue (Tufts)	6.5
Dark Green (Tufts)	10.1
Dark Brown (Sumptner)	13.0
Bright Red (Tufts)	16.2
Dirty Yellow (Sumptner)	20.0
White Sandstone (O'Connor)	24.0
Gray paper (Tufts)	50.0
Light colored wood (Sumptner)	50.0
Whitewashed ceiling (Harrison)	80.0
Dead White (Hallock)	80.0
White cardboard (Tufts)	92.3

The percentage of light absorbed by various shades with the authorities is as follows:

Clear glass (O'Connor)	6.0
Clear glass engraved (O'Connor)	40.0
Frosted glass (Lewes)	11.2
Ground glass (O'Connor)	29.5
Alabaster glass (Palaz)	15.0
Opal glass (Palaz)	20.0
Milky Opal (Palaz)	30.–60.
Opal glass colored (O'Connor)	64.0

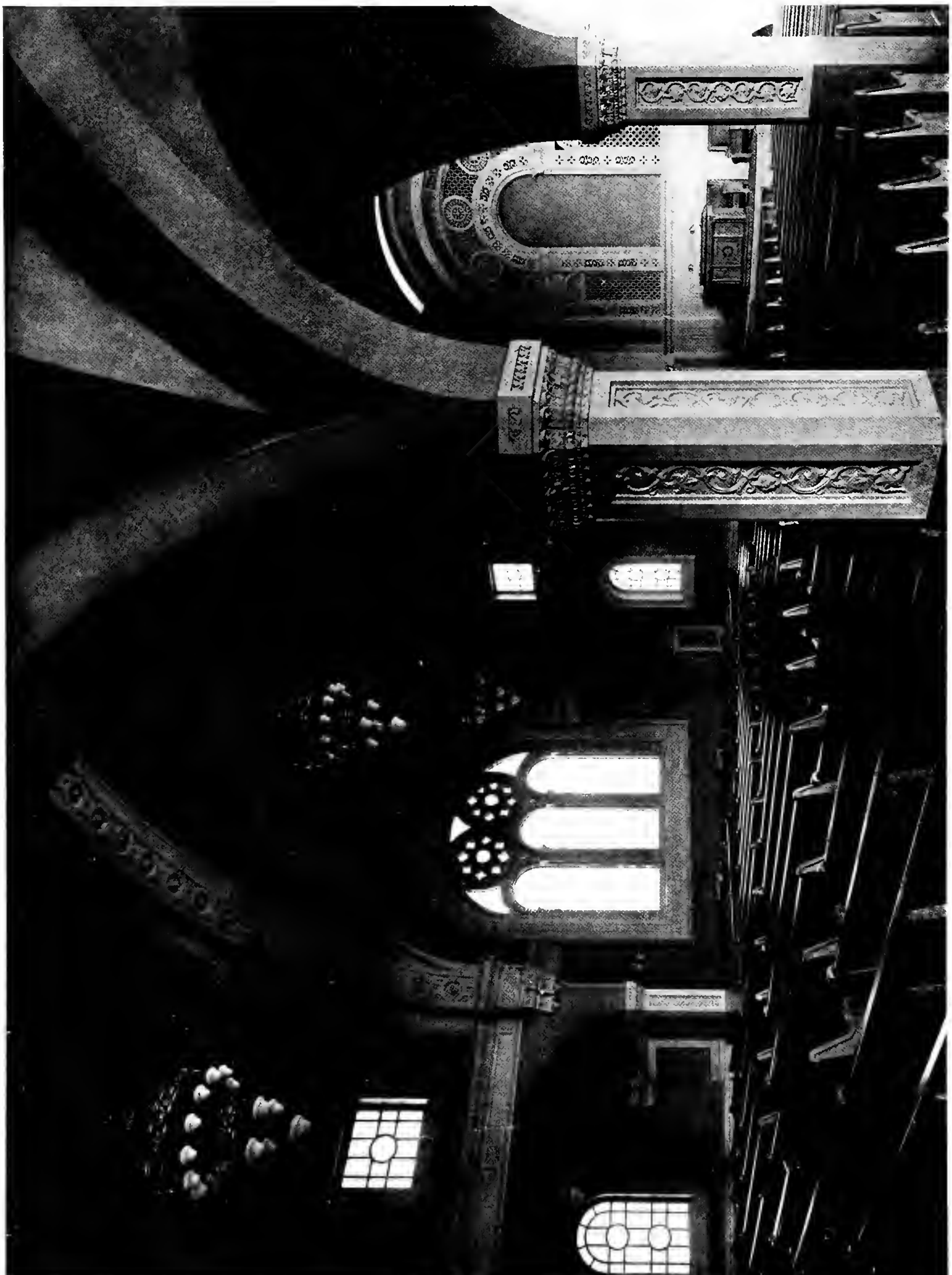
The use of reflectors has become quite general but the data on coefficients of reflection varies as may be seen in the following table by Bell:

Highly polished silver	.92
Mirrors silvered on surface	.70–.85
Highly polished brass	.70–.75
Highly polished copper	.60–.70
Highly polished steel	–60
Speculum metal	.60–.80
Polished gold	.50–.55
Burnished copper	.40–.50

Great care should be exercised in regard to the brilliancy of the source of light. The eye should never be forced to look at a source whose intrinsic brilliancy exceeds 5 candle power per square inch. The intrinsic brilliancy of the various sources of light is shown in the following table:

	Candle-Power Per Square Inch	
Moore tube	0.3–	1.75
Frosted Incandescent	2–	5
Candle	3–	4
Gas flame	3–	8
Oil lamp	3–	8
Cooper Hewitt lamp		17
Welsbach gas mantle	20–	50
Acetylene	75–	100
Enclosed A.C. arc	75–	200
Enclosed D.C. arc	100–	500
Incandescent lamps:		
Carbon 3.5 watts per candle		375
Carbon 3–1 watts per candle		480
Metallized carbon 2.5 watts per candle		625
Tantalum 2.0 watts per candle		750
"Mazda" 1.25 watts per candle		875
"Mazda" 1.15 watts per candle		1,000
Nernst 1.5 watts per candle		2,200
Flaming arc		5,000
Open arc lamp		10,000–50,000
Open arc crater		200,000

The modern methods of church illumination are as varied as the buildings themselves. There are, however, certain facts that have been established by experiment and the natural evolution of lighting such edifices. There should always be general illumination in addition to the light applied to the surfaces when required for special objects so that



FIRST CHURCH OF CHRIST SCIENTIST, SAN FRANCISCO, CAL.

MR. EDGAR A. MATHEWS, *ARCHITECT*

(For additional illustrations of this subject see index)

the eye will be rested and not constantly be trying to focus on account of variation in light conditions. There should be no naked lights of high candle power but shades, ground glass bulbs, and other devices should be employed to prevent glare. The quality of the light on the interior should be mellow. No direct rays of light should be directed into the eyes of any person. It is a mistake to attempt to eliminate all shadows as they have their value in producing the desired result. But great care should be exercised to have no shadow on any surface where the light is used for a specific purpose such as reading. Lamps should be renewed when they reach the point in their life that they give 80% of their rated candle power.

The most modern and satisfactory method of lighting the chancel is by placing a continuous reflector back of the piers on either side and the arch at the ceiling. This has been done in many cases, probably the most modern is the Cathedral of St. John the Divine in New York.

The pews can be lighted properly by means of electrolier, or lights at the capitals. If there is a gallery, lights must be placed under it to kill the shadow. This can be done by brackets on side walls or lights sunk into the under side of the gallery. Great care should be exercised to have the correct balance of light under the gallery. The lighting of the pews is governed entirely by the type of architecture and scheme of decoration. The color scheme should be adopted in conjunction with the lighting possibilities as either can render the other incongruous. The changing of colors can be seen by the schedule of Ritchie on the second following page:

As a rule the ceiling should not be lighted except by what naturally filters there from the illumination of the spaces below.

Special light tight reflectors should be provided for the clergy, organist, and choristers, to throw light only on the pages to be read. The general illumination should not be sufficiently high to enable them to read easily as it will then be too high for proper effect and eye ease in the body of the church.

Windows have been successfully lighted in two ways. One method is to place lights between the inner and outer window in reflectors with glass screens of different density so as to flood the stained glass with lights modified at proper points for the design.

The second method can only be used when conditions on the exterior permit. This is to place lights outside the windows and above same with reflectors to throw the light through the stained glass.

It will be seen, therefore, that the illumination of a church is not a problem to be solved in a general way but each building must be worked out by itself, and by one familiar with all the sources of light, the method of installation, the natural laws, the physiological laws, and the architectural design. In short, it is a problem which can be properly solved only with the co-operation of the Architect and Consulting Engineer.

ST. PAUL'S CATHEDRAL, DETROIT, MICH.

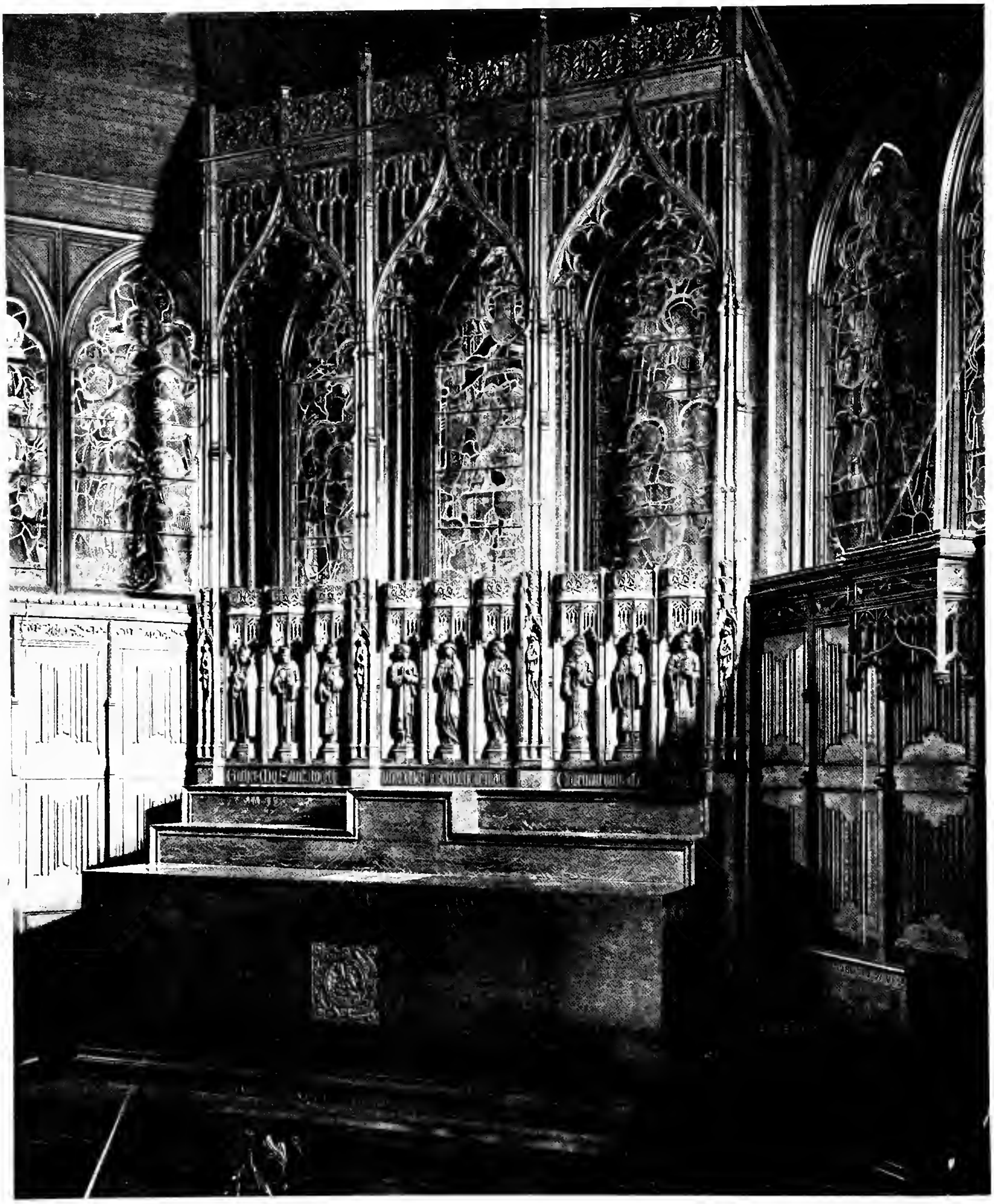
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

(For additional illustrations of this subject see index)

RITCHIE'S SCHEDULE OF COLOR

(Referred to on second preceding page)

Description of Light Used	Appearance	COLOUR					
		Brown	Red	Green	Mauve	Blue	Orange and Yellow
Bright diffused daylight	Bluish white or pure white	Normal	Normal	Normal	Normal	Normal	Normal
Inverted O. I. arc lamp	Bluish white or pure white	Normal	Slightly brighter than normal	Normal	Slightly darker than normal	Normal	Normal
Enclosed arc lamp	Bluish white	Darkened	Lightened several shades	Darkened considerably	Darkened slightly	Darkened slightly	Darkened slightly
Metallic filament incandescent lamps	Yellow white	Lightened and changed to reddish tint	Lightened many shades	Darkened and changed to a yellower tint	Changed to redder tint	Darkened and changed to purplish colour	Brightened and changed to a more orange shade
Inverted incandescent gas	Greenish yellow	Darkened	Lightened many shades	Darkened and changed to a yellower tint	Darkened and changed to a redder tint	Darkened and changed to a more navy blue	Brightened many shades
Carbon filament incandescent lamps	Orange yellow	Reddened in tint	Lightened many shades	Darkened and changed to a yellower tint	Darkened and changed to a pinker tint	Darkened and changed to a much more purple colour	Brightened and changed to a deep orange
Ordinary gas light	Yellow	Reddened in tint	Lightened considerably	Changed to a yellower green	Changed to a pink rose coloured tint	Darkened and changed to a more navy blue	Brightened and changed to orange
White flame arc lamp	Bluish white	Slightly reddened in tint	Lightened many shades	Changed to a yellower tint and lightened slightly	Changed to a bluer and darker shade	Brightened and changed to a more intense blue	Changed to a deeper and more orange colour
Yellow flame arc lamp	Deep yellow	Darkened slightly	Changed to a brick red	Deadened and changed to a yellower colour	Darkened considerably and changed to a purple	Darkened and changed to a more navy blue	Changed to a deeper and more orange colour
Mercury vapour lamp	Pale blue-green	Changed to a greenish colour	Changed to almost black	Lightened considerably	Changed to a slate-blue grey	Deadened	Changed to a greenish yellow



ALTAR AND REREDOS

ALL SAINTS CHURCH, GREAT NECK, L. I., N. Y.
MESSRS. CRAM. GOODHUE & FERGUSON, *ARCHITECTS*

THE ORGAN FROM THE ARCHITECT'S STANDPOINT

By ARTHUR WHEATON CONGDON, A.A.I.A.

THE bulk of the church organ causes it to be the most conspicuous article of furniture in any room where it is placed, and the fact that its size makes it a fixed part of the interior at once suggests its use as a part of the design. The organ builder is generally a resourceful man, and more than once has made up for the architect's lack of foresight by his ingenuity. It is the purpose of this article to consider the organ in relation to the design of the building, leaving details of construction to some of the well-known textbooks on the subject.

An organ placed in a large church would naturally be designed by its builder mainly for the support of chorus singing, while that in a concert room or residence would be mostly used as a solo instrument in which great power would seldom be required. All details of construction, determining the manner of placing the organ in the building, are the same, differing only with the bulk of the instrument.

The instrument that we know as "an organ" is really a combination of several instruments which may be played separately or in various combinations. In the first place, every organ has the main subdivisions that show as separate banks of keys. One of these is intended to be played by the feet, and is therefore called the "pedal" organ; the others, played by the hands, and hence called "manuals," are known as the choir, swell, great, solo and echo organs, each having its own manual. A very small organ may have but one manual, while a large one may have three or four manuals, or banks of keys. The pedal and manual keyboards are grouped together with the stop-knobs and other mechanical devices, as will be explained later, the whole being known as the "console." This may be attached to the organ and form a part of the case, or it may be detached and even in a remote part of the building, connected to the organ by electricity or otherwise.

Each manual has its own set of stops, as has the pedal organ. Each set of stops represents a complete musical instrument, the scale generally corresponding to the keys, and being as complete in itself as is a pianoforte, with the exception that the number of notes on an organ keyboard is less, the pedal keyboard including only thirty-two notes, and the manuals generally sixty-one. Each stop that is drawn on a particular keyboard will sound on that keyboard, and if several stops are drawn several notes will sound for each key that is depressed; moreover, by means of the "couplers," the different keyboards may be connected, and not only at unison pitch, but also at an octave above or below, so that the pressure of one finger may be made to sound a great many different pipes.

The different departments of the organ may be placed together or, in the case of a large building, may be divided, so that the echo organ may be in the roof or other remote position; and the rest of the instrument may be further divided and placed on opposite sides of the stage or chancel, or a part may be at each end of the auditorium. This makes a variety of effects possible to the skilled performer, and also makes the instrument more flexible as a decorative feature; but such divisions should be made with considerable discretion owing to the number of pitfalls for the unwary. It is obvious that for unity of musical effect the parts of the instrument should not be too widely scattered, and if it is to be used to accompany singing, great care should be taken that the placing of these divisions of the instrument does not affect their value adversely for purposes of accompaniment.

There is a certain church in which a very fine and costly organ has been spoiled for practical use by its unwise division; part of it is placed very low down, close to the choir and directly back of the organist; and part of it has been placed in a gallery in the other end of the church. The result is that the portion close to the organist screams in his ears so that he cannot hear his choir, while the part placed in the gallery is so distant that the choir cannot hear it above the uproar of their own singing; and the organist can never hear both parts of his instrument at once when playing them together.

The division of the organ and the placing of the console are dependent in large measure on the kind of action used, whether electric, pneumatic, or the old tracker action. The architect must have some idea of which is to be used, and should be in a position to advise intelligently between them.

The "action" of the organ is the device which transmits the pressure of the finger on the key to the pipe and causes it to speak; it has no reference to the motive power for the bellows or blower, as is supposed by some persons. Thus an electric organ may be blown by hand, or a tracker action instrument blown by electric power. Tracker action, the oldest and simplest of all, takes its name from the trackers, which are strips of wood connecting the levers of the keyboard at one end, and the organ-pipe valve at the other. Its merit is that it is positive and dependable, and seldom gets out of order even when neglected, and when broken is easily repaired by any mechanic. Its fault is that in large organs it makes the touch extremely heavy, so that the organist labors, rather than plays; this is particularly true when the manuals are coupled together.

Another fault is that the console must always be close to the organ, and is generally attached thereto. This makes it awkward if the organ is to be placed in a music hall where on occasions an orchestra or a chorus is to be accommodated. Tracker action is in common use, however, for small organs, particularly if they are to be placed in remote villages where a proper mechanic can be obtained only once a year.

The next development in organ action was the tubular pneumatic. In this the impulse is taken from key to pipe by means of compressed air, through leaden tubes filled with air under a slight pressure which is increased by the pressure of the key on a little bellows. This form of action is better than the old tracker, as it is so much lighter in touch even when the whole organ is coupled together; and it is also free from the defect of a possible partial opening of the valve by a touch lacking in positiveness, which is apt to give a false note. It permits the console to be detached and at some distance from the organ, but in a fixed position. This distance should not be over about thirty feet, as the compressibility of air will make the action slow at a greater distance. The action is a durable one, as the only things to wear out are the rubber connections of the valves with the metal tubes, and when in need of repair is not difficult to mend.

The electric action is the most recent development. In it the impulse is taken from key to pipe by means of an electric current of low voltage, the pressure of the key making a contact, and the current energizing an electro-magnet in the organ, which in turn operates the pneumatic valve at the pipe. It is, therefore, sometimes called "electro-pneumatic" action. Owing to the vagaries of electricity it is less dependable than either of the foregoing actions, because if anything does go wrong a skilled mechanic is required to locate the trouble. Each day sees improvements in it, however, and as the knowledge of electricity becomes more widespread this form of action will probably become universal, even for small instruments. It is, of course, instantaneously quick, so that the console may be placed at any distance from the organ permitted by the slow rate of travel of sound; and as the necessary connection need only be by a slender flexible cable the console may be freely movable. Owing to the great ease with which the electricity can be controlled, much more variety of mechanical device may be designed; and an electric console may have a bewildering array of more or less helpful devices which, if intelligently used, make musical effects possible that cannot be attained with any other form of action.

In all three forms of action composition

AISLE CASE OF ORGAN, ST. THOMAS'S CHURCH, NEW YORK
CRAM, GOODHUE & FERGUSON (BOSTON AND NEW YORK), *ARCHITECTS*

pedals or pistons are provided by which a number of stops may be drawn by one motion on any manual; but in the electric action this may be further amplified by making the same piston draw a combination of stops on the manual, alone, or add to it the proper pedal stops by pressing the piston or key harder; and a "suitable bass" key may be provided, after pressing which any change in stops made by hand will automatically make the suitable changes in the pedal registration. Another arrangement makes it possible to draw a stop on a manual other than its own.

If the action may be likened to the nervous system, the blowing apparatus is obviously the lungs of the organ. The early organs were blown by a bellows like that used by the smith in his forge. As this does not give a steady wind pressure, a wind reservoir was made, fed by one or more bellows or "feeders." The modern organ, with its varied resources, calls for more wind, and in response to this demand blowing apparatus of a special type has been developed, in which the requisite air pressure is maintained by a rotary fan usually direct-connected to an electric motor. This motor takes its current from the street mains, and is therefore generally of an alternating-current type. Such motors are apt to make a humming or buzzing sound while running, and as the fan or blower may do likewise, the whole apparatus should be enclosed in a sound-proof room and placed at as great a distance from the audience as possible. The wind-trunk, which conveys the air to the organ, should also be provided with a suitable check-valve and flexible sleeve so as to prevent transmission of the sound along the air-current or through the metal of the pipe. The architect should take care with the placing of these blower sets that they should be able to take in and deliver air to the organ that is free from dirt or dust, and is at about the same temperature as the air of the auditorium. This is necessary in order to keep the organ pipes in tune as well as to avoid chilling the auditorium or filling it with foul or musty air; and as the amount of air passing through the pipes of a large organ in the course of an hour's recital is very considerable, it is obviously a matter for serious attention.

The rotary fan or blower is only possible where electric power is available; in more remote places and with smaller organs the blowing apparatus used is a bellows, or reservoir with feeders, worked in the familiar manner of pumping up and down, or if there are three feeders, they may be operated by a wheel and crankshaft. Both methods are largely used, the former being necessary only when a reciprocal-action water-motor is the source of power. Water power applied in this manner is generally reliable, but the architect should make sure that ample supply and waste pipes are provided; a 3-manual organ will require a 2-inch supply pipe at the usual city pressure. Care should also be taken that the motor-room is made sufficiently accessible so that the motor valves may be packed and otherwise attended to at regular intervals; otherwise, the grit may cut the metal parts and make costly repairs necessary. The motor room should also be protected against freezing.

It is better always to have some form of power to operate the bellows. If a man or boy has to be depended on he is seldom available at the time when the organist wants to practise, and is particularly liable to the failings of the flesh when he is most needed.

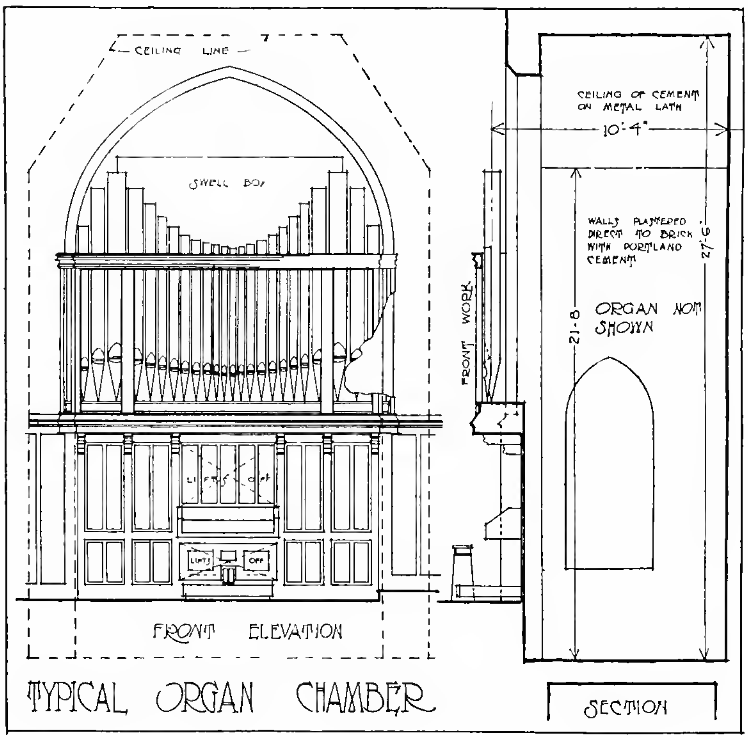
The designing of the organ chamber and its relation to the rest of the plan is peculiarly the architect's province, as no amount of ingenuity can get the best results out of a badly placed instrument, although the organ-builder shows a remarkable ability in overcoming difficulties. It is a lamentable fact that the architect may be to blame for the weakness of tone and lack of brilliancy of many a costly instrument owing to a poorly planned organ chamber. Few of us seem to realize how large and bulky even a small organ is; and a costly instrument takes up a surprising amount of room both in height and floor space, so that its location in the plan is a matter calling for serious thought.

The organ need not be placed in a chamber; it is not always a necessity, and where by a little forethought it may be

SOUTH CHURCH, NEW YORK

CRAM, GOODHUE & FERGUSON (NEW YORK OFFICE), *ARCHITECTS*

avoided and the organ placed in a gallery or otherwise in a portion of the hall or room it is almost sure to gain in beauty of tone. Where it is necessary to place it in a chamber, as is usually the case in churches having chancel choirs, the first requisite of such a chamber is ample floor space. If the pipes have to be crowded together they will tend to muffle one another's sound at best, and at worst the laboratory experiment of "interference of sound waves" may be repeated on a large scale, and certain pipes when sounding at the same time may actually neutralize one another's tone in whole or in part so that little or no sound is produced. Moreover, if pipes are so packed that they cannot be reached readily for purposes of tuning they may be slighted altogether or not tuned as often as the rest of the instrument; and some may be so inaccessible as to render the journey to them dangerous to the tuner as well as to the delicate mechanism of the instrument.



Quite as important a requisite is ample height, for an open pipe speaks out of its mouth or top, and if this is too close to the ceiling the tone may be impaired or even altered in pitch; also, as heated air arises these longer tubes being at a higher temperature than the rest of the organ they will go out of tune during the concert or service when the additional people and lights and lack of ventilation combine to raise the temperature of the room above its normal.

It is very important that the chamber should open into the main room with as little obstruction to the sound as possible; the ceiling should follow the line of the arches in order to avoid pockets, and the arches should not be choked up with too dense a mass of front pipes or organ case. It is possible to overcome the existence of pockets in some measure by the use of reflectors of concrete or wood, but these are only makeshifts after all.

Unquestionably the free-standing organ is the most effective musically; nothing could be better for sound than the position of the organs in the Continental cathedrals in their galleries or the English ones on top of the choir screens. In a recently finished church the old organ was moved from its badly planned chamber to a proper gallery with regret that so inefficient an instrument should have to be used in the new church even temporarily, and great was the surprise of the congregation when they heard the full, sweet tone of their old organ in its new position. It leads one to ponder how much better many a good organ might sound if placed to better advantage.

It is unfortunate that there is no standard of size for organs as there is for pianos, for example; when one is asked how large an organ chamber ought to be there is no very definite answer that can be given. Only a few makers list stock sizes and these are seldom used except for the smallest and cheapest instru-

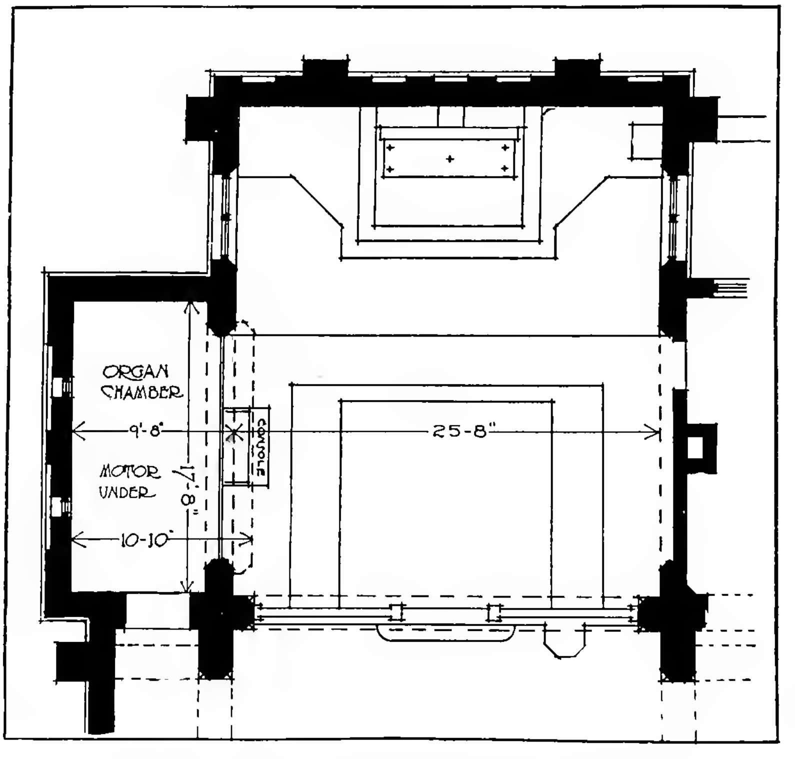
FIRST BAPTIST CHURCH, PITTSBURGH, PA.
CRAM, GOODHUE & FERGUSON (NEW YORK OFFICE), *ARCHITECTS*

ments; generally the instrument is planned for the building according to its needs.

In our own practice we have found that for a small church, say one seating about four hundred persons, a chamber about fourteen feet deep and eighteen wide will accommodate an organ costing about $5,000; and we try to get it at least twenty feet high at the sides and higher in the middle, following the line of the arch. In a large church or in a concert room where four or five times this sum may be spent very much more room must be provided. A large organ may have a 32-foot open stop in the pedal department, the longest pipe of which would be about 40 feet long; and even if it had only a stop of 32 feet tone, using a 16-foot stopped pipe, there would be such an array of other pipes, swell boxes, etc., that the organ would have to be built in two or more stories, requiring a total height of over thirty feet, not counting free space above the pipes.

Mention has been made of the necessity of providing pure air at a proper temperature for the blowing apparatus; it is quite as important that the organ chamber should be well ventilated and kept at about the same temperature as the rest of the room. Ventilation is necessary to preserve the delicate and perishable wire, leather or rubber parts of the mechanism which would be damaged by gas fumes, and the necessity for equable temperature is apparent when one considers that a change of a dozen degrees of temperature will alter the pitch of metal pipes about a semi-tone; as the wooden pipes remain constant or nearly so, the effect is awful to contemplate. For this reason it is best not to have any windows in the organ chamber; in winter they may chill a part of the organ, or if sunlight enters through them a part may be heated by the sun's rays more than the rest and the result will of course be disastrous to the effect of the whole.

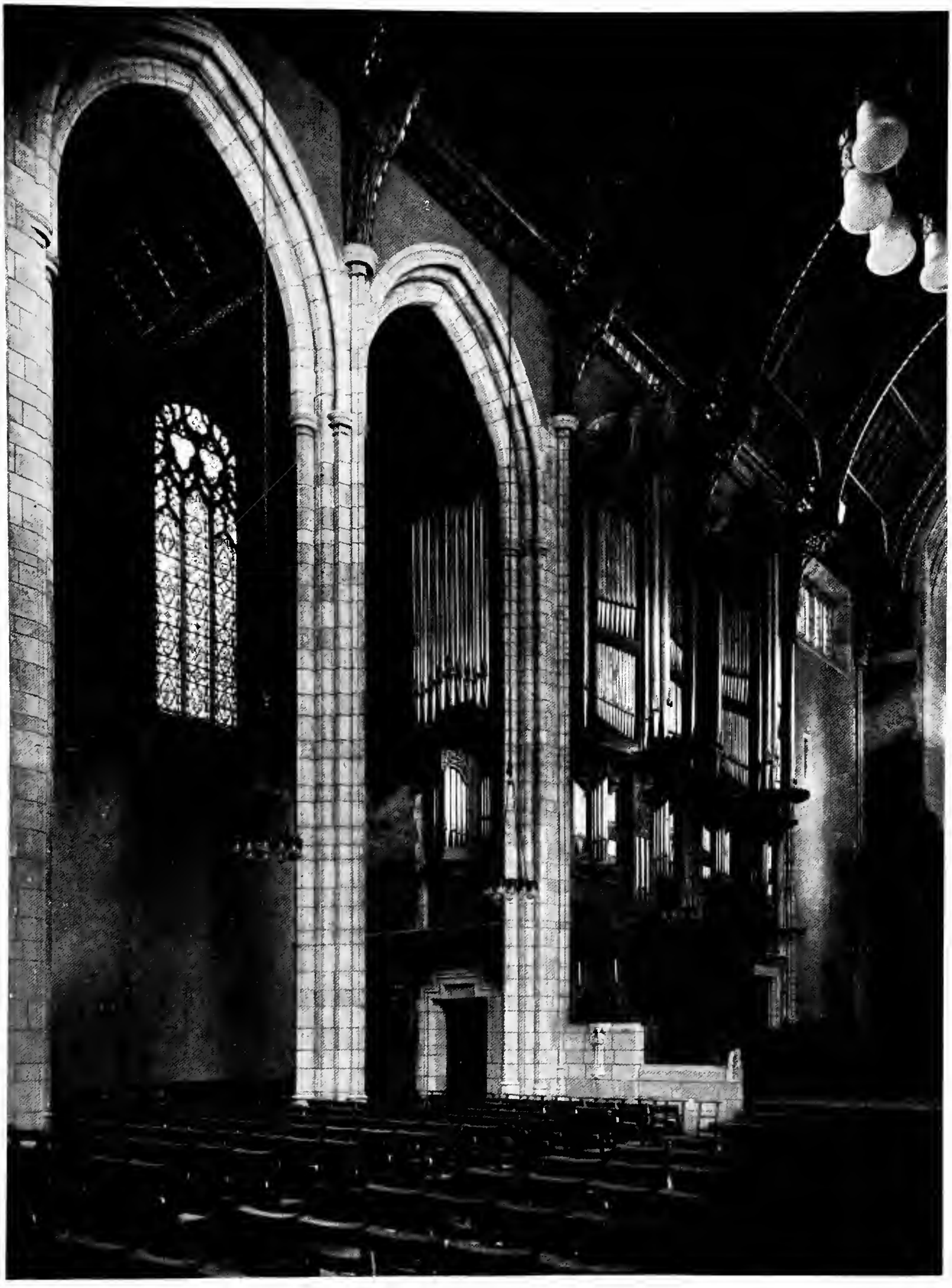
It follows that no radiator or heater ought to be placed in the organ chamber, nor should the boiler room be located in the cellar beneath the organ, for even if it did not heat it unevenly it would dry out the woodwork to an injurious extent, causing costly leaks and rendering the delicate action unreliable.



PLAN OF ORGAN CHAMBER AND CHANCEL

In placing an organ in a gallery or on a wooden floor the framing should be amply strong to support the great weight of all the metal pipes; if there is the least settlement there will be a corresponding change in relationship of the mechanism and trouble will ensue. We may assume the weight of the organ at from 150 to 200 pounds per square foot, according to its size, and to endeavor to frame so that there will be as little settlement as possible from timber shrinkage.

The walls of the organ chamber, or the space back of the organ, ought to be con-



CHAPEL OF THE INTERCESSION, NEW YORK
CRAM, GOODHUE & FERGUSON (NEW YORK OFFICE), *ARCHITECTS*

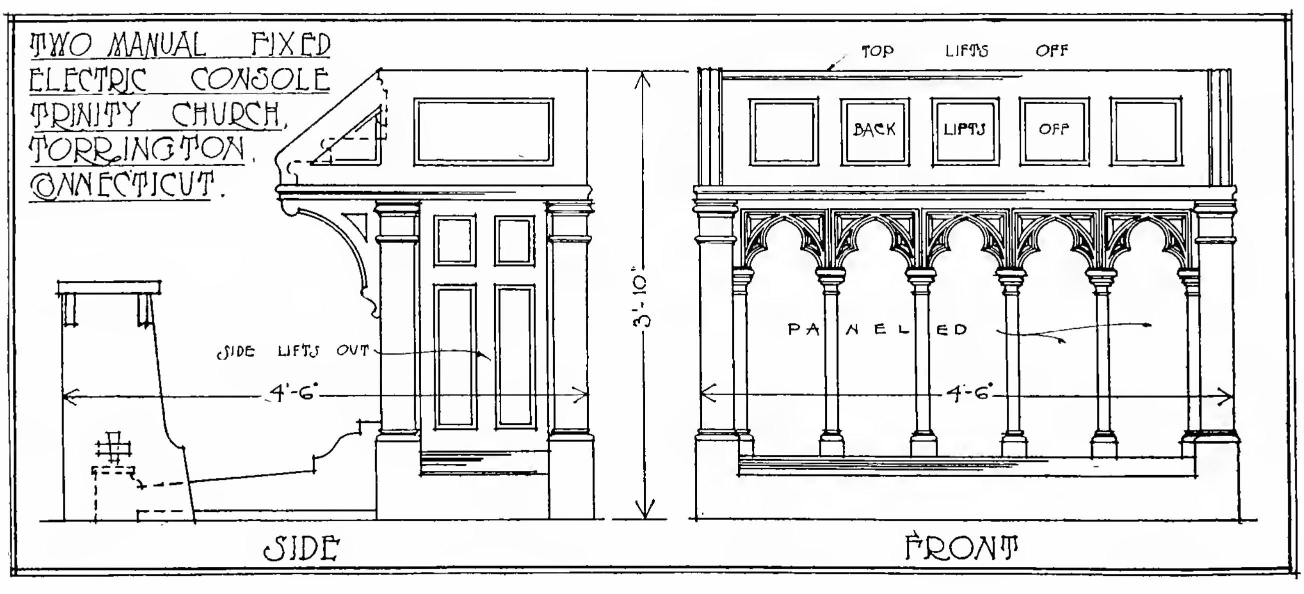
creted directly on the masonry without furring, and on metal lath in the case of ceilings; this adds greatly to the resonance and hence to the power and richness of tone of the instrument; raising the organ in a gallery also seems to have a good effect, as the little defects of sound, the hissing of leaking wind, the clatter of pneumatics, and so on, are lost in the distance.

The thoughtful architect will also provide wall plugs for portable electric lights for the use of the tuners; many a fire has been started by the tuner's candle, and the interior of an organ, with its great mass of dry wood, is a risk that should be considered.

The possibilities of division of the organ have been referred to; care should be taken in planning for this that the distances are not made too great. Sound travels only 1,120 feet per second, and the human ear can readily detect intervals finer than the one-twenty-fifth of a second; therefore no two parts of an organ that are to be played at the same time should be separated by more than sixty feet; but this need not prevent the location of the echo or solo organs in all sorts of odd and out-of-the-way places. In Garden City Cathedral, for example, the echo organ is in the roof above the vaulting, and another division of the organ is in the basement robing room. In Cleveland Cathedral a stop of the solo organ is in the basement and the sound is reflected up through ventilator faces at the back of the nave, the effect of a swell being produced by varying the positions of the concrete reflectors.

The architect's next care will be for the location of the console or key-desk, if it is not to be attached to the organ. In the case of concert halls it is important to be able to place the console anywhere; but if the detached console is to be a fixture it should be arranged so that end or other panels may be removed in order to get at the action without disturbing other fixed furniture. Space behind the organ bench should also be provided, so that a tall man may shove it back; it is as hard for him to play close up to the console as to ride a boy's-size bicycle. If there are any architectural reasons why these matters cannot readily be arranged the organ builder should be consulted before the plans are entirely fixed.

The size of the console varies greatly. Naturally, the console of a small organ is smaller in all its dimensions than that for a large one; and that for an electric action is smaller than a tubular-pneumatic console, sometimes by a foot or more. It is safe to assume a space about five feet square on the floor for the console and more in width if possible; the depth increases only when there are more manuals and the height is almost a constant unless there are a great many stops.



In the purchase of an organ of any size the services of an expert adviser are almost imperative, in which case the architect may safely leave the consideration of the organ specification to him, retaining control only over the provisions for organ case.

Organ specifications are very different from those which we prepare in our offices for the mason and carpenter; they are little more than lists of names of the stops that are to be included in the instrument. The choice of these is a specialty with which the architect had better not interfere without special training; but as the adviser to his client there are certain points in an organ specification that he should be familiar with.

The costly stops in an organ are the "foundation stops," and an organ needs a foundation of tone quite as firm as that for a building. The diapasons, particularly the open, both in pedal and manuals; the bourdon in the pedal and sometimes in the manuals, and the tibias are foundation stops. These must be of ample scale or diameter in proportion to height and must be of good materials of heavy weights in order to give the necessary solidity and richness of tone. In wooden pipes white pine is used almost altogether; in metal pipes a mixture of tin and lead is used, 25 per cent. of the former being good practice; if it is richer, say 50 per cent., the result is called "spotted metal," and makes a very beautiful front pipe without any painting or gilding; its tone is very brilliant, and it is generally used in this country only for the slender pipes of the string-tones. Zinc is often used, especially in cheap organs; it does not give as rich a tone, but it stands rough handling better.

The thickness of the metal is of more importance than the species; this and the scale of the pipes is never specified by a maker, and one must judge him by his former works. The scale, or diameter of the pipe, fixes the body or largeness of the tone, as the length does its pitch; it is dependent on the size of the room to be filled, and also on the wind pressure to be used. A cheaper, small-scale pipe may be used by an unscrupulous builder with a high wind-pressure to give the same amount of tone as the large-scale pipe of higher cost, but it is notably lacking in that mellowness and "golden" quality beloved of the poets, that one hears in the famous foreign organs.

In considering the organ specifications submitted with the competitive bids the committee will naturally count the number of stops that are specified, and as it is a usual device to number and include in the list such useful but inexpensive items as "Bellows Signal" and "Tremulant," knowledge on the part of the architect will make his advice much more helpful to the committee. These things are easily allowed for; but it is less noticeable to the casual observer when a stop is split in two, as "Bourdon Bass" and "Bourdon Treble," where the two stop-knobs merely control the lower and upper parts of one stop. The addition of the so-called "fancy stops" is of value to a concert organ, but in a church organ these comparatively inexpensive stops add little or nothing to the power of the instrument, and are chiefly useful for greater variety in soft solo playing; nevertheless, they swell the list of stops just as much as do the more valuable but also more costly stops of foundation character. It is difficult to draw the line between these and the fancy stops, but among the latter are found stops with such names as Unda Maris, Vox Celestis, and the like; the foundation stops seem to have simple names like Diapason, Flute, Tibia, and so on.

Generally a diagram or series of notes in the specification is provided to make clear just how many really speaking stops there are, and how often these are borrowed. The value of this borrowing is a vexed question from a musical standpoint, and many cogent arguments are advanced both for and against it; but it undoubtedly adds to the variety of tone combinations at a small expense, while it does not pretend to increase the power or body of the tone in any way.

The compass of the keyboards, both manual and pedal, is always specified by the number of notes in each; modern organs have more than the old-fashioned ones, as they are required by modern music, and one should note with care whether the specification calls for the modern range of 32 notes on the pedal organ and 61 on the manuals. Note also whether all the stops run throughout this range; in a cheap organ the more costly stops may lack their lower and even their upper parts, pipes being provided only for the middle register. This makes an inferior instrument for every purpose, but it permits a large number of stops for a small outlay, as the lower or bass notes always require the most costly pipes. If the specification does not distinctly call for all stops to run through the complete keyboard a schedule should be called for showing the range of each.

The pedal keyboard on old organs is flat, and all the keys are parallel, like a magnified piano keyboard. In a board of this sort the lower and upper notes are so far away from the performer as to make playing on them difficult. To obviate this a keyboard has been devised which is concave and in which the keys radiate from a centre behind the player; in this the middle and the two end keys are theoretically equally easy for the performer to reach with his foot. This board has been adopted as a standard by the representative body of organists, the American Guild of Organists, and should be provided in all organ specifications. The Royal College of Organists of Great Britain has adopted a similar pedal-board.

The couplers that are provided are not always numbered in the list of stops, but if this is done allowance should be made for them by the committee; they have their legitimate uses, and a certain number of them are necessary; but they are so easy to multiply under modern mechanical methods and cost so little that they should not figure as a competitive feature in the specification.

The specification should also state whether the combination pistons or tablets move the stop-knobs or not. Most organists prefer that this should be done, but it complicates the console and adds to its size as well as its cost and is not a necessity in a small organ. In large organs, particularly those that are to be played on by a number of different performers, the registers or stop-knobs certainly should be moved by the combination pistons; in cases where this is not done an indicator is provided, but this is of little use to a stranger and is apt to get out of order.

A feature of the specification that requires attention is the motive power for the blowing apparatus. Sometimes this is not provided under the organ contract, and sometimes a motor may be specified that is not permitted by the local laws, as many towns will not permit the use of a water-motor, and the more expensive electric apparatus will have to be used. In any event, the matter of power ought to be clearly understood, and if a rotary blower is to be used, it should be definitely specified as to make; and the electric motor, if specified, should be one that will suit the local variety of electric current.

The specification ought also to make provision for the case and console. It seems hardly necessary to advise that these should be designed by the architect of the building.

Organ cases may be roughly classified in three types: the first, in which the organ stands free, either in a gallery or on a screen; the second, in which the organ is placed in a chamber or niche, and is merely provided with a front; and the third type, which is seldom found outside of Italy, in which the front is provided with doors like a triptych. The second is the type generally found in Episcopal and other churches, where the instrument shows on the chancel side only, or occasionally has an additional front on the transept side.

The triptych is a type that gives the greatest opportunity for richness of effect, and seems particularly applicable for organs in residences. In penitential seasons these Italian organs have their doors closed, and, as these are much plainer on the outside, the effect on the interior of the building is most marked and adds not a little to the dramatic effect of the penitential devotions. Where organ cases have been provided with these shutters, it has been said that a marked improvement is observable in the mechanical department of the organ; the action wears better, and the instrument stands in tune longer, owing to the protection given by the closed doors. This, of course, presupposes the closing of the doors during the very considerable periods during which an organ is not in use.

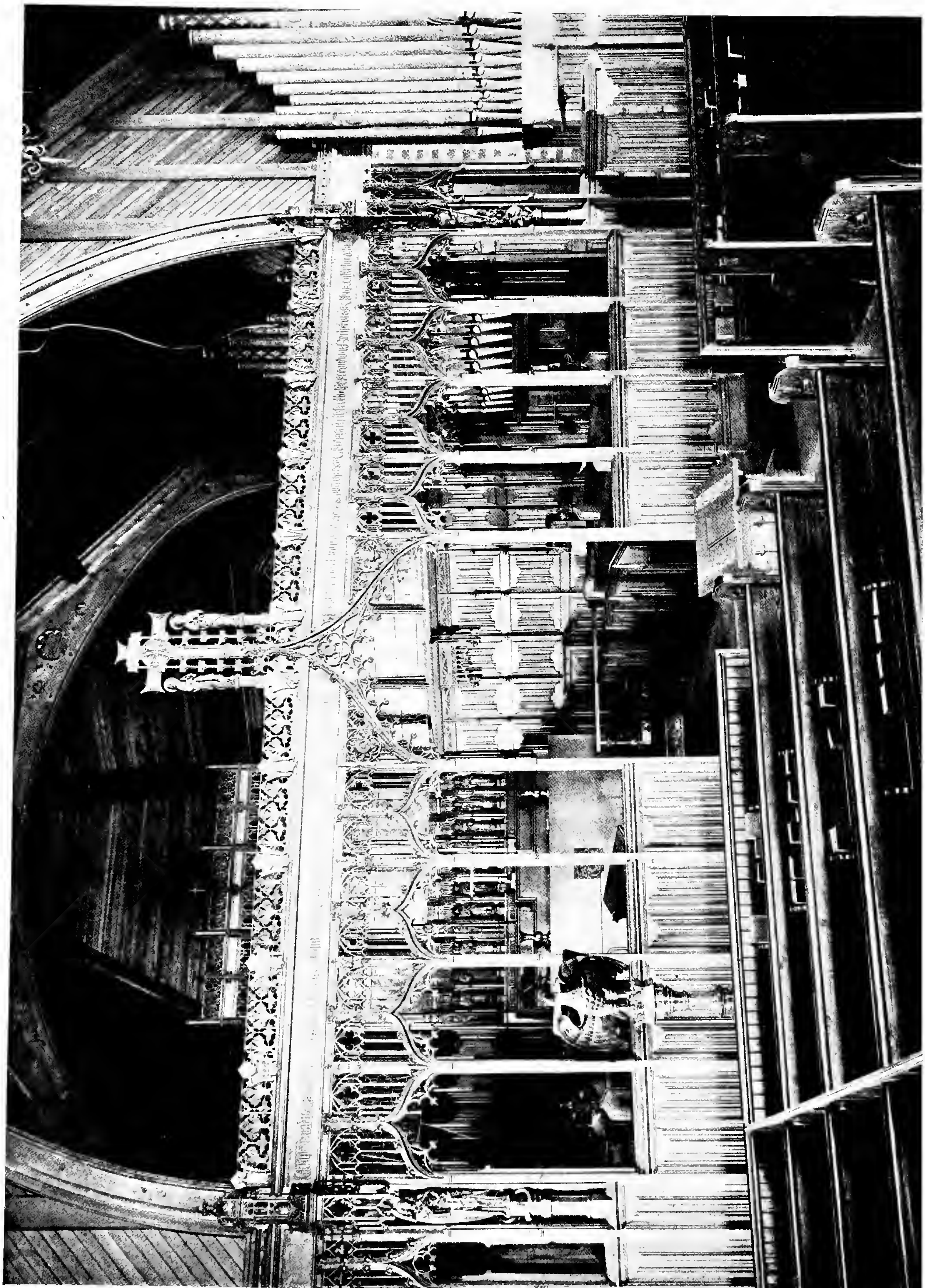
A variation of this type of considerable interest is the organ in the church of Sta. Maria della Scala, Siena; here the organ pipes form a very small part of the decoration and the case-work is magnified to the limit. It has been taken as the motive for the organ case in the New England Conservatory of Music, where the result is so successful that it should commend itself as an inspiration to anyone seeking to design a fitting focus for the music-room of a dwelling or the stage of a concert hall.

Sometimes an organ is placed without any case at all, the stark, bare pipes standing naked and unashamed.

The painting or gilding of the front pipes is so common now as to be tiresome; the old organs generally left the front pipes in their natural color, a much more refined method than the garishness of the gilded and polychromed pipes of the late '70's.

Great variety of arrangement of the pipes in the case is possible, but the architect should consult with the organ builder before his design has taken too definite form and obtain from him a careful layout of the front pipes along the lines of the sketch for the proposed work; this will serve to fix the scale of the parts and will obviate the expensive and unsatisfactory device of dumb pipes. The diameter of the pipes is fixed according to the scale of the organ and their position musically; but the height may be made a variable quantity by the use of dumb tops extending beyond the real top of the pipe. This is not a satisfactory device, however, and should be avoided if possible. The pipes should always be arranged with reference to ease of tuning; in some of the examples shown herewith certain pipes must be dumb, or they could never be reached by the tuner. It must be remembered that a pipe is always tuned at the top and not at the lip; reeds are tuned in a position corresponding to the lip of a pipe, but as they are not of decorative value they are not used for display pipes, nor are the wooden pipes, as a rule.

Much has been done already to lift the organ to its proper place in the scheme of decoration, but much more can be done, and it is to be hoped that architects will not only consider the placing of the organ in the plan from the practical standpoint, but will also pay more attention to its very great possibilities as a feature in the interior composition, and that they will use their influence with their clients to promote this end. Musically, the organ has a dignity and nobility that is unique, and architecturally it has latent possibilities for the development of these same qualities.



ACOUSTICAL CONSIDERATIONS IN CHURCH ARCHITECTURE

By WALLACE C. SABINE

NO other problem presents to the architect acoustical difficulties in such varied form as that of church design. Other auditoriums are relatively standardized, and while the departures within this standardization may be such as to produce good or bad acoustical results, these departures are generally along few lines. The theatre, the lecture room, and the concert hall are, compared with the church, almost conventional, and the variations are in a few planes, in dimensions, and in decoration. In the church, on the other hand, the gamut, in size from chapel to cathedral, in form from the American church architecture of the middle nineteenth century to the ecclesiastical architecture of Europe, is beyond parallel in any other type of auditorium. In plan, a church may be circular or square; it may be rectangular, and broader than deep, or, longer, and very much longer, than it is broad. In elevation, its ceiling may be spherical, or barrel shaped, or plane, it may be groined, or timbered; it may be a lantern, approached by plane sloping surfaces, or flanked and supported by a cross of shallow arches; it may be a nave, with or without transept, or apse, or aisles. Almost none of these, or of the many other types that occur, are to be unqualifiedly condemned, and all may be adapted, though with varying readiness, to give at least moderately good results. Finally, to cap the complexity, the problem must concern itself both with speech and with music, aspects not necessarily inconsistent, but certainly not identical.

When the problem is so infinitely varied its discussion, in order to be so complete as to be a guide in design, must not merely explain the general principles but must follow them in all their ramifications. To this end it would be necessary to discuss in detail such subjects as reverberation, interference, echo, and resonance; it would be necessary to redefine them, to explain the methods of their determination and their computation, and their significance in arriving at the ultimate solution. It is out of the question to undertake all this within the space of the present paper; it is possible, however, to explain broadly the essential considerations relating to church acoustics.

It is necessary to emphasize that no single feature in design is necessarily incorrigibly bad from the standpoint of acoustics, or, alone, a guarantee of good results—neither a detail, such as a ceiling which is flat, or barrel shaped, plane or coffered, walls which are broken by columns, by pilasters, or plane, not large aspects of the problem such as the style of architecture, be it Romanesque, Gothic, or Colonial, nor indeed even the size, although this is more difficult to control by other counterbalancing features. The problem is one whose ultimate result depends in every case on several factors, on size, on form, in large and in detail, and on the materials employed throughout in the construction. For example, a dome intolerable in one position may in another, with a different radius of curvature, and above all of a different material become not merely tolerable but positively good. The Gothic and Romanesque cathedrals of Europe show acoustical difficulties which are more dependent on the materials of which they were composed than on their form, difficulties which are not unavoidable with materials which are known today. On the other hand, early Colonial churches were on the whole acoustically good, better indeed than much of the corresponding English

Georgian, because, in part at least, of the kind of plaster employed and the method of its application—a kind no longer common, and a method no longer possible.

It is equally necessary to emphasize the fact that a considerable acoustical effect can be accomplished only by a considerable change in design or in construction. Very insignificant changes are often advanced for the remedying of large and often fundamental acoustical difficulties, such, for example, as the stretching of wires, the rough trowelling of walls, the painting or the sanding of walls, or the placing about the room of hollow plaster busts, the one as worthless as the other. It has even been proposed to use the flow of air for the ventilating of the room to carry the sound from the speaker to different parts of the audience. Indeed, one may find in some otherwise very creditable discussions of the subject, the roughness of a wall surface spoken of as a factor in its reflecting power. As a matter of fact it is utterly inconceivable that any finished surface should have a texture such that its mere roughness would be a factor in its acoustical quality. To look for such an effect is to ignore on the one hand the relatively great length of the waves of audible sound, and on the other the extremely small, indeed microscopic, amplitude of vibration of the air. By the same reasoning it is possible to show that the stretching of wires is valueless. Nor is it difficult to show that, while in certain auditoriums and in certain positions statuary is valuable, it is so not because it is hollow, and not in the auditoriums nor in the places for which it often has been proposed. A notable change in the acoustical quality of an auditorium can be accomplished only by a notable change in the shape, the size, or in the materials employed in its construction. But the important thing to bear in mind is that the value of the latter, as a factor for better or worse, should be determined not by guesswork, analogy, or even loose qualitative reasoning, but by an accurate quantitative measurement of its reflecting power. With this data in hand, it is possible to determine in advance of construction the exact acoustical quality which will result from any fully determined design.

Thus it is possible to calculate all the physical factors that go to determine the quality of an auditorium and to express these physical magnitudes numerically. It is possible for one who has so analyzed many auditoriums and has had experience of them to know the quality which such figures define and to say in advance of construction whether a hall built according to a certain design will be good, bad or indifferent, and indeed to qualify these grades. But this is not sufficient. It expresses merely his opinion. It is true that his judgment may be exceptionally well trained; it probably is. But, nevertheless, rather should it be possible to say whether a particular design would result in a church which by common consent would be classified as having a certain quality. Common consent is obviously a laborious standard to establish in any field of inquiry. It is especially difficult here in view of the not inconsiderable labor involved in figuring a single church, the number of churches which should be examined, and the great variety of standards. For a hall designed for orchestral music or chamber concerts the task is by no means so formidable, for the number of competent critics whose opinion is worth while securing and the number of halls worthy of analysis is relatively few. Not merely does the church vary more in type and in the service which it is to render, but the competent critics of its acoustical quality are much more numerous. No inconsiderable headway has been made in this task. Already over fifty churches have been measured and analyzed, preliminary to their correction, and most valuable data has been thus secured. But such material relates to the lower part of the scale—to churches whose normal construction has called for more or less drastic correction. To complete the scale of critical opinion it is necessary to similarly measure and analyze churches which have met with approval as well as many from that large number which are indifferent in quality. It should be possible in this way to establish a scale of five grades of very good, good, indifferent, bad, and very bad.

It is easily possible to lay altogether too great stress on the fact that the church problem is one which concerns both speech and music and that the best conditions for each of these are somewhat different. While it is possible to lay too great stress on this fact, it is an even greater error to ignore it altogether.

For speech two qualities alone are essential, loudness and clearness; the one cannot be obtained except somewhat at the expense of the other. The reflections of the sound from even the nearer walls and ceiling surfaces, which very greatly re-enforce the loudness, in some measure at least detract from its clearness. The determination of what constitutes good acoustical quality is the determination of the best balance between these two conflicting conditions. The extreme condition in either respect is bad. Thus, speaking out of doors on an open and level plane without encircling walls or trees is a condition in which the distinctness is wholly unimpaired, but the volume of sound is insufficient except for certain types of address. On the other hand, numerous cases are within the experience of every one in which loudness is secured at the excessive expense of clearness. It is not necessary to cite examples; it is a too familiar phenomenon. In brief, loudness and clearness are inter-dependent; one is desirable, one is undesirable; and good design consists in making the loudness of the distributed sounds as great as possible consistent with not excessive echoes or reverberation.

For music the case is different; for here reverberation has a positive value of its own. Probably under no condition does music sound to less advantage than in an unrestricted space. One may quote so excellent an authority as Mr. Geriske, the former conductor of the Boston Symphony Orchestra, that even the partial confinement of a city street greatly enhances the music of a band. Reverberation has not merely a slightly sostenuto effect, introducing a delicate harmony into even single part melodic composition, but also enriches the harmony of full part music, and above all serves to take from music a thin staccato quality which is perhaps best realized by comparing, even if only in imagination, a piano played indoors and out of doors far from any limiting walls. In moderation, reverberation enriches the harmony, renders the tones more full, and rounds out the attack. In excess, it so prolongs the tones that harmony becomes discord and the rounding of the attack becomes its complete obliteration. Thus in music reverberation is present not by sufferance, but by intention; by good design it is present to an accurately determined degree. Churches illustrative of the extremes, of too little and too great reverberation, are Saint John in Cambridge, and Saint John the Divine in New York.

While loudness on the one hand and echo and reverberation on the other are determining considerations in the majority of cases there are two other phases of the acoustical problem which occasionally become important factors,—interference, not infrequently, and, though far more rarely, resonance. Indeed all five, loudness, echo, reverberation, interference, and resonance are factors in every acoustical problem. In any particular case their importance in the order named is inversely as the size of the auditorium. It is obvious, without argument, that the difficulty of securing adequate loudness and of avoiding excessive echoes is greatest in a very large auditorium; and, other things being equal, reverberation is proportional to the linear dimensions. On the other hand, interference exists only when some of the sounds reflected from the walls or ceiling surfaces are coincident, at least in part, with the sound which has come direct. Only when the difference in paths travelled is slight do the sounds overlap; and only when they overlap do they interfere. Obviously thus, interference is a pronounced factor just in proportion as the distances to some of the wall or ceiling surfaces are small measured from either the speaker or the audience, and, therefore, that the smaller the auditorium the greater the phenomenon of interference as a factor in that aggregate which is called its acoustics. Finally resonance, using this word in its true sense, is the reaction of the reflected sounds on the speaker himself. It is obvious in this case that the distance of the wall surfaces from the audience is immaterial, and that only the distance from the speaker is a factor. Only in a very small room or where there is a convergence of surfaces near the speaker is resonance an important consideration.

Reverberation and resonance affect equally the audition in all parts of a church. Local difficulties and the so-called deaf spots are due to the other two adverse factors, echo and interference. In by far the greater number of cases where such singularities are pronounced the difficulty is due to a combination of echoes. These echoes are generally not distinguishable from the direct speech, but nevertheless come at so long an interval as not to serve to re-enforce the voice which has come directly from the speaker. This aspect of the localized problem calls for little discussion of a general nature; it is an obvious factor. The other factor, interference, calls perhaps for some explanation. If a key on the organ is held depressed while coupled by the drawn stop to a relatively pure toned pipe such as a wooden diapason or metal gemshorn the phenomenon of interference is easily observed. At any one point the sound is constant, but varies when the observer moves there being regions of silence not far from regions of relatively great loudness. This phenomenon is due to the fact that two sounds of the same pitch arriving at a fixed point may re-enforce each other or may neutralize each other according to the manner in which the waves coalesce. This system of distributed intensities varies with the pitch, the distances from maximum to minimum being generally the greater the lower the note. In articulate speech the characteristic notes, which are by no means the ground notes of the voice, change with great rapidity, and the resulting interference systems have time to form coincident with the direct speech only when the room is small or the distance of the reflecting surfaces short. It is for this reason that the phenomenon of interference is not a more troublesome factor in architectural acoustics and that it is only under special circumstances that it contributes to the formation of the so-called deaf spots.

The whole development in building materials and in methods of construction during the past thirty years has been in such a direction as to make the chance of satisfactory acoustical results in a church, if the acoustics be left to chance, scarcely a third of what they were thirty or forty years ago, even leaving out of account, although this is fairly within the reckoning, an increased dignity in ecclesiastical architecture in America and a development of its forms on a more generous scale. One may cite the increased use of stone and cement, or that plaster is more often applied directly to the tile and brick where formerly it was held from the wall on studding. Moreover it is now applied in thickness two or three times as great as formerly; and for the sake of quick setting and drying, patent hard plaster is used instead of the old mortar plaster. Each of these improvements is admirable and has its entire justification in other considerations. But while these mechanical difficulties in the way of good acoustics have increased there has on the other hand been an increased demand for good acoustical quality, partly because of a greater emphasis on the sermon and the spoken service, partly because of an increased impatience on the part of the congregation with the necessity for excessive effort in giving sustained attention. It is an exceedingly interesting observation that this insistence on the importance of the spoken service is quite as great in the ritualistic churches as in others. These two conflicting tendencies have between them greatly increased the severity of the architect's problem.

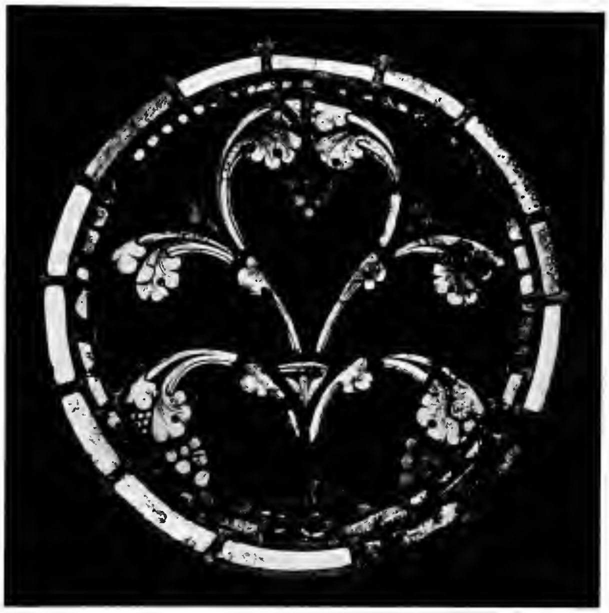
STAINED AND PAINTED GLASS

By GEORGE HERBERTSON CHARLES

WINDOWS in colored glass, leaded, have long been known, popularly and technically as "stained glass windows," but the term is not comprehensive, as all colors, with the exception of a true yellow stain obtained by silver salts, are colored in the pot when the glass is made, or white glasses are flashed with thin coatings of colored glass. Most reds are obtained by the latter method.

Both colored and white glasses are painted and leaded, and the distinctive features of stained glass windows are, in fact, more accurately described by the terms "painted and leaded."

This noble craft has inspired lovers of growing color since primitive colored glass was made, and the happy expedient of enlisting the blessed light-o'-the-sun to vitalize an artist's expression was first employed.



ENGLISH XIV CENTURY GLASS
FROM SALISBURY

To those who respond to its distinctive appeal, all other mediums seem at times tame and ineffectual by comparison. It alone, among the materials with which we are familiar, offers the singing splendor of pure transparent color transfused with light.

Its very limitations, in the hands of those who love it, but add to its power and charm. The intense blacks of leads and stay-bars are ideal settings for the jewel-like color and lustrous whites of a well-composed window.

Nowhere is this more apparent than in the masterpieces of the twelfth and thirteenth centuries, when the difficulties which faced the artist and craftsman were so largely in evidence. Glass was made only in small pieces, the palette was limited, and it was well-nigh impossible to match colors accurately in different pots. Naturally, too, many mistakes were made in attempting various colors, so that instead of being lured into mechanical repetition, or staid and scholarly formulæ, the maker of windows was kept vivid and fresh, and "being bound in the flesh was set free in the spirit."

Consider any one of the rich treasures of Chartres, of Bourges or of Reims. Is it not true that many of its rare virtues are to be traced to these very limitations? Of course their value was in a sense negative, and without the propelling force of a genius for relatively perfect expression in color, no worthy result would have been achieved. The important point to consider is, that with later improved facilities, when the artist was no longer "hampered" by such limitations, he was led far afield, and left the glories of that day for the polished and inept trivialities, the mechanical and tiresome accuracies, with which we are all too familiar.

It is useless to attempt to discount the achievements made in the production of any material for which there is a legitimate use. The enlarged palette and other increased facilities, offered to the artist who works in glass, should be encouraging and enlightening, rather than confusing.

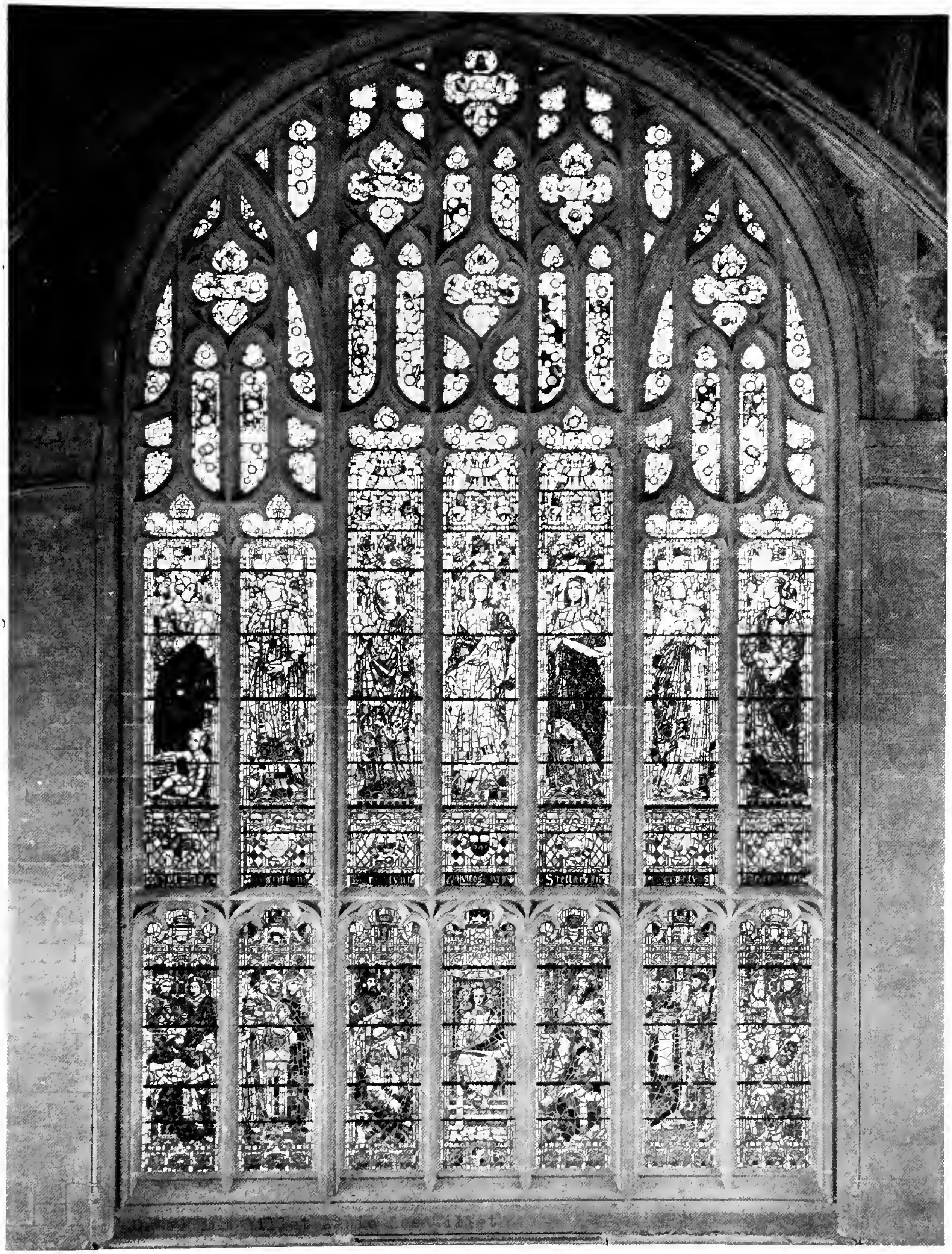
Results are disastrous only when, tempted by an almost unlimited range of color, and by an alluring array of devices to disguise the rugged verities of his craft, he forgets the fundamental principles on which it is founded.

These principles could not be stated more clearly or more accurately than in the following words from the "Vitrail" of Viollet le Duc.

"What have been lost or forgotten during many centuries are the true manners which alone are suitable to painting of glass; manners dictated by study of the effect of light and optics; manners perfectly understood and employed by the glass painters of the twelfth and thirteenth centuries, neglected from the fifteenth century on, and afterwards disdained, in spite, as we have said, of the immutable laws imposed by light and optics. To try and reproduce what is called a picture, that is to say, a painting in which one seeks to render the effects of linear and aerial perspective, of light and shade with all their transitions, on a panel of transparent colors, is an undertaking as daring as to attempt to render the effect of the human voice with stringed instruments. Different processes, different conditions, different branches of art. In an opaque painting, in a picture, the radiation of the colors is absolutely under the control of the painters, who, by halftones, shadows of diverse intensity and values, according to the different planes, can diminish or augment it at will. The radiation of transparent colors in glass cannot be thus modified by the artist; whose whole talent consists in profiting by it to work out a harmonic scheme on a single plane, like a rug, not in working out effects of aerial perspective.

SECTION OF A MODERN WINDOW BY CHRISTOPHER WHALL, IN GLOUCESTER CATHEDRAL

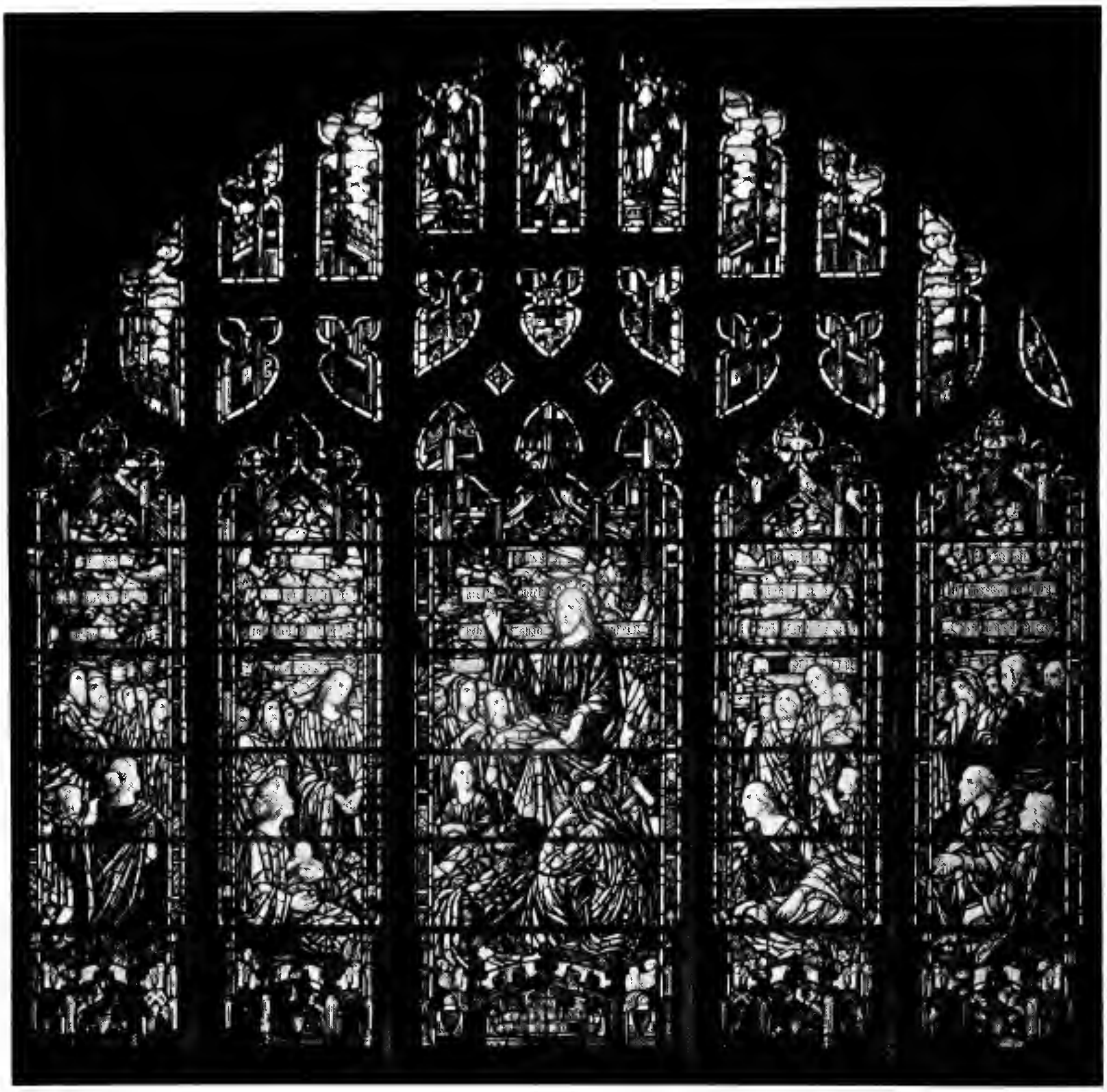
"In spite of all that one can do, a glass window never does and never could represent more than a single plane, it loses its true qualities except under that condi-



GREAT WEST WINDOW, PROCTOR HALL, GRADUATE COLLEGE, PRINCETON UNIVERSITY

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*
DESIGNED AND EXECUTED BY WM. WILLETT AND ANNIE LEE WILLETT

tion, every attempt made to present to the eye a series of planes destroys the harmony of the colors without producing any illusion for the spectator. . . . Transparent painting can never aim to be anything but a drawing or design second-



MEMORIAL WINDOW, "SERMON ON THE MOUNT", MEMORIAL CHURCH OF ST. PAUL, OVERBROOK, PA.

ing as energetically as possible a harmony in colors, and, when it is so treated the result is successful. To try and introduce the peculiar characteristics of opaque painting into transparent painting, is to lose the precious qualities of the transparent painting without possible compensation. This is not at all a question of custom or blind affection for an art which we might try to maintain in its archaism, as is sometimes asserted; it is an absolute question, since (we cannot repeat it too often) it is one decided by physical laws whereof we can change no whit. You will never be able to make a guitar sing like Rubini, and although some people take pleasure in listening to the overture of William Tell played on the flageolet, that can scarcely be the taste of true music lovers."

The sincerity and good taste of many present day architects have done much to restore respect for this decorative art so closely related to architecture. Their influences are to be felt in a renewed, intelligent interest in great achievements of the past, and in a growing demand for work by inspired artists and craftsmen

ENGLISH—GLOUCESTERSHIRE, EARLY XV CENTURY

today. This is, of course, as it should be, for the first consideration of the maker of windows should have to do with the building which is to contain them. The problem of church lighting, while it reveals fascinating possibilities, offers sobering responsibilities which architect and "glassman" must share.

In no other decorative medium are successes more gratifying in their power to enhance the distinctive character and beauty of an interior, nor are any other failures so fatal to the efforts of the architect, and of all who may have striven with him, to glorify and enrich the inner fabric of a church edifice.

So obvious a fact should scarcely need to be mentioned; but when we recall the vast number of unsuccessful windows in the churches of our cities and towns, naturally the architects' knowledge and judgment in respect to them are sure to be questioned.

A comparatively recent report by the Committee of Education of the American Institute of Architects has ably suggested the dilemma which faces the American Architect in his effort to secure the efficient co-operation of American Craftsmen.

"In the good old days when an architectural monument was a plexus of all the arts, the architect was pretty much at the mercy of the craftsman, and he still is, with a difference, for then every bit of sculpture or painting or carving or metal work and joinery, and glass and needle work, when these latter came into play, enhanced the architecture, glorified it, and sometimes redeemed it as well; now either our carving is butchered, our sculpture and painting conceived on lines that deny their architectural setting, our metal work turned out by the commercial ton, our stained-glass work defiant of every law of God, man or architect, or it is all reduced to a dead level of technical plausibility, without an atom of feeling or artistry—and we are glad to take it this way for the sake of escaping worse."

These words should have the thoughtful consideration of all who are interested in window-making, for they present, perhaps rather too darkly, a situation that

AT LEFT:—CROCKER MEMORIAL WINDOW, ST. GABRIEL'S CHURCH, MARION, MASS.
MESSRS. SHEPLEY, RUTAN & COOLIDGE, *ARCHITECTS*

AT RIGHT:—FRAGMENT OF A WINDOW AT NEWTON CENTER, MASS.
DESIGNED AND EXECUTED BY MR. C. J. CONNICK

has long been particularly evident in reviews of the work of our shops and studios.

Another aspect is equally worthy of presentation. There are men in practically every large city, who are striving earnestly to express, sincerely and frankly, the high ideals which this medium might well be expected to evoke. Some of them are working under pronounced difficulties, many are struggling against unequal and unfair competitive conditions; all sorely need recognition, direction, and encouragement.

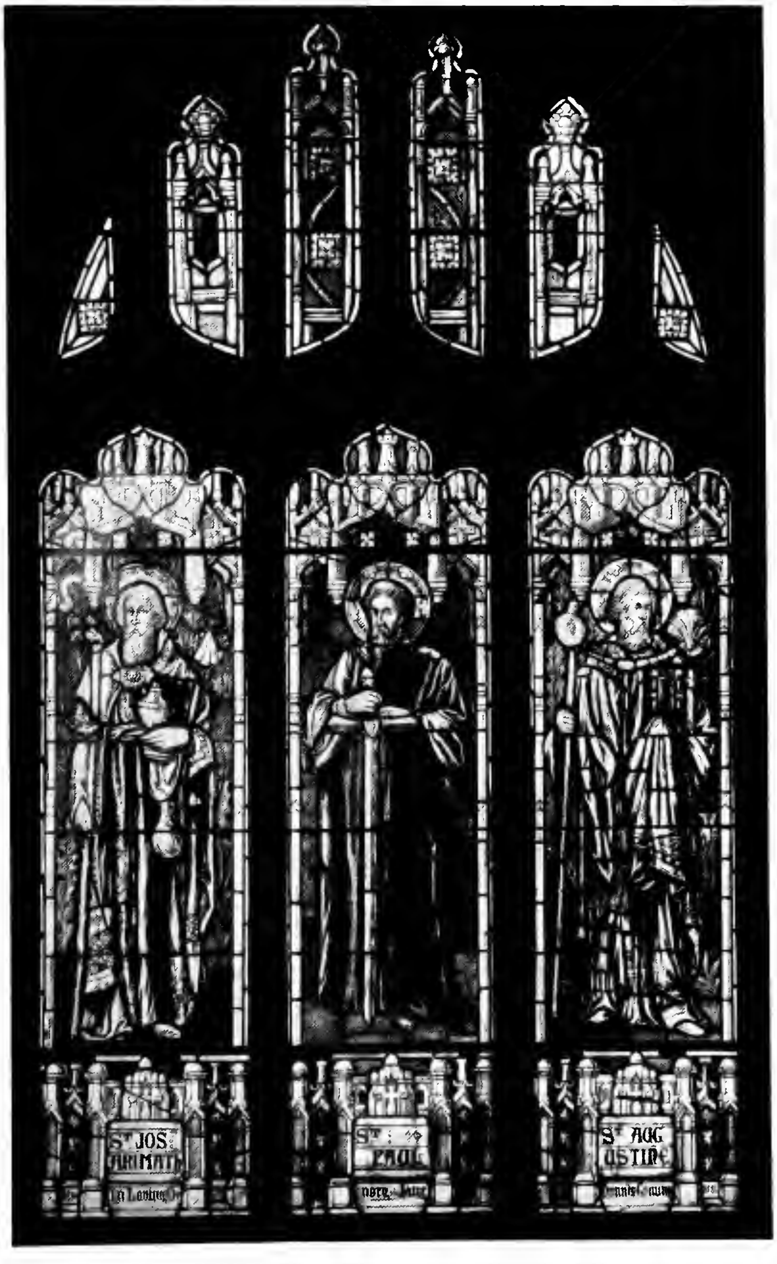
Thoughtful architects have recently, with praiseworthy far-sightedness, searched out just such artist-craftsmen, and results have not only justified their efforts, but have led to marked changes of most splendid promise.

It is also their manifest intention, when confronted with the problem of church lighting, to study glass and lead and paint in varying stages as they are wrought into windows, at first hand, in the studio and workshop.

One of the first things they discover is that the making of glass in rich, pure color such as was used by the masters of old, is no lost art, as many writers on the subject may have led them to believe. What is lost is the widely diffused love for it, and the consequent small demand for such colors from the glass makers themselves.

When the windows designed by Burne-Jones for St. Philip's Church in Birmingham were made some twenty years ago, but little difficulty was found in securing prismaitc colors which rivaled the glories of the famous glass in Chartres. The glass used was "antique," in sheets, furnished by a well known London glass firm. The windows are now universally recognized as examples of noble thought and work, carried to the pitch of perfection in design, and comparable to the best work of the masters of old in full, true color.

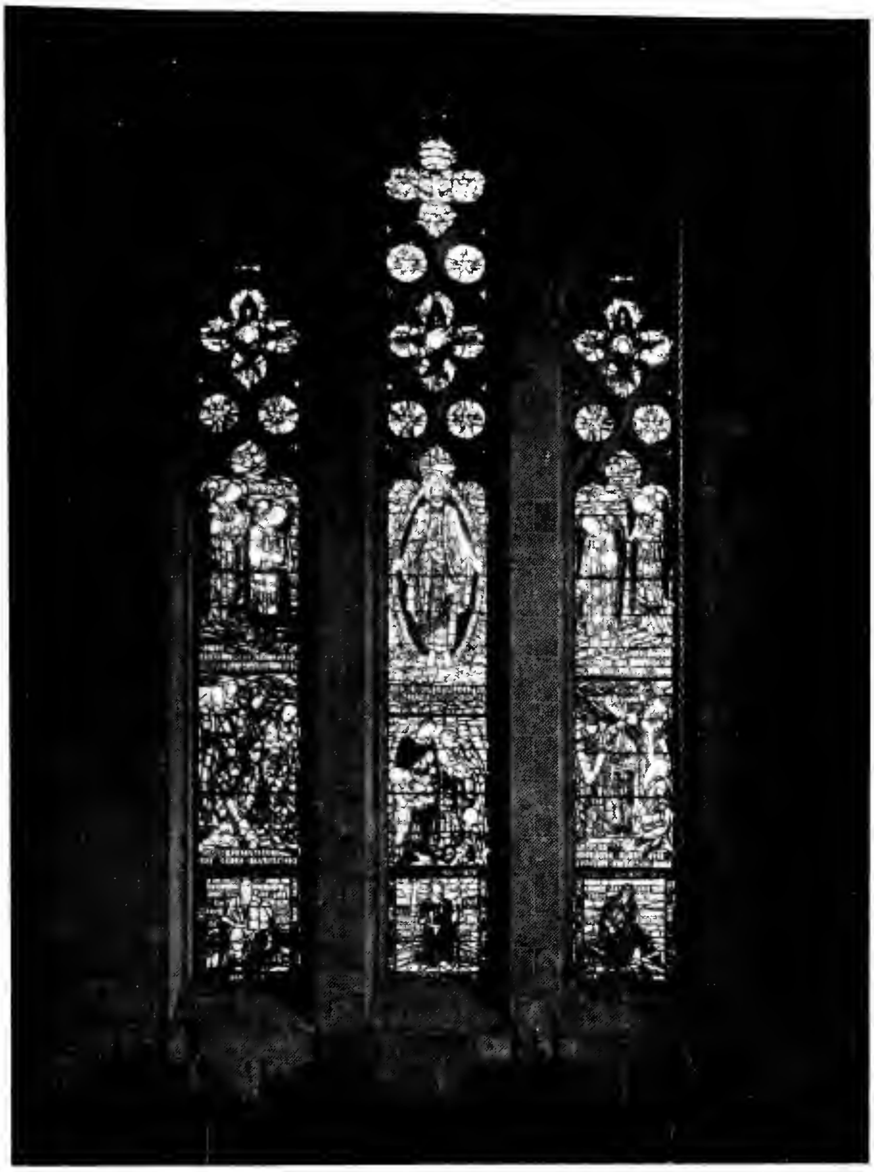
Later when Christopher Whall, Louis Davis and other ardent lovers of the craft demanded glass more nearly resembling that of the twelfth and thirteenth centuries, glassmakers in England were remarkably successful in producing ma-



CLERESTORY WINDOW, TRINITY CHURCH,
ASBURY PARK, N. J.
EXECUTED BY HEINIGKE & BOWEN

"THE LAST JUDGMENT"

WINDOW BY SIR EDWARD BURNE-JONES IN ST. PHILIP'S CHURCH, BIRMINGHAM, ENGLAND



THE GREAT CHANCEL WINDOW. FOURTH PRESBYTERIAN CHURCH, CHICAGO, ILL.
DESIGNED AND EXECUTED BY CHARLES J. CONNICK
CRAM, GOODHUE & FERGUSON & HOWARD VAN DOREN SHAW, *ASSOCIATED ARCHITECTS*

terial which left but little to be desired.

This glass is known variously as "Bottle Glass," "Norman Glass" and "Norman Slabs," and is made of comparatively small masses of glass, blown and whirled into bull's-eye glass, or blown into shapes which are broken when cooled, into oblongs or slabs of varying thickness.

To those familiar with the thorough and painstaking treatise of Theophilus, and with the exhaustive "Vitrail" of Viollet le Duc, this will be seen to resemble closely the essential methods of the early glassmakers.

The latter authority wrote in this connection, as follows:

"From the decorative standpoint, the bull's-eye glasses, or those roughly spread out, present an advantage. Since these glasses were colored in the mass, at least during the twelfth and thirteenth centuries (with the exception of the red); the difference in thickness of the plates of glass caused graduations in tone, which the glazers employed with great skill by cutting the glass so that the thinner pieces came at the lighter parts of the design. Even in solid backgrounds these variations in thickness gave an appearance of changing lustre to the colors which, at a distance, augments singularly the intensity of the tones. All colorists know that to give a color its full value, it must be presented to the eye only in little pieces, in bursts, so to speak."

So widespread has the soft attraction of dull and safe neutral colors become, that these wonderful glasses are comparatively unknown in this country. The reason for timidity on the part of American designers and makers of windows is perfectly obvious. The light to which windows are here subjected is intense to the point of harshness, and an unhappy juxtaposition of pure color results in a lusty discord of terrific power.

The tendency has been, therefore, to nullify and obscure the light, and this inclination is doubtless responsible for the introduction of the so-called opalescent glass, which, notwithstanding its long

THE LOWER HALF OF THE PRODIGAL SON WINDOW IN THE CATHEDRAL AT BRUGES. A FAMOUS EXAMPLE OF THE MEDALLION WINDOWS OF THE XIII CENTURY
DRAWN BY CHARLES J. CONNICK

period of favor among us, was never accepted seriously by European craftsmen.

One reason why opalescent glass continued its American vogue for so long was that English windows designed for a softer light, in whites and colors more or less neutral in tone, were fairly shot to pieces by our powerful light.

It came to be quite generally accepted that "Antique" glass was too thin and transparent for use in American windows, and opalescent glass, opaque and rather undefined in color, was for a time looked upon as our own distinctive and adequate material.

In many instances English painted windows were plated on the outside with huge sheets of opalescent glass, and the heterogeneous mass resulting, was successful at least in obscuring the light.

This problem is not a new one. In parts of France, and in some few in England, an intense light has demanded the thoughtful consideration of the window artist. Therefore, the solutions he offered are extremely interesting to us. The representative twelfth and thirteenth century windows would seem to have answered gloriously in their color alone all requirements for subdued light; but if they could at once be divested of the dust of centuries, and of the curious erosions which atmospheric conditions have wrought, the skill of the painter-designer in utilizing intense light to ad-

TRANSEPT WINDOW, HOUSE OF HOPE CHURCH, CHICAGO
CRAM, GOODHUE & FERGUSON, *ARCHITECTS*
EXECUTED BY YOUNG & BONAWITS

vantage would be more clearly revealed.

Viollet le Duc was unquestionably right in his contention that the twelfth century glass painter had a perfect understanding of the laws governing radiation of color, and these words, inspired by an artists' joy in full color and tempered with scientific knowledge, are indispensable in this connection.

"These artists knew first, that tones have only a relative value; second, that the radiation of certain transparent colors is such that it alters or modifies the quality of these colors themselves; third, that painting applied on glass should, even in the most heavily shaded parts, allow the neutral tone to be seen, not through a film but by bits of pure color; because a shadow which completely covers a colored glass gives, at a distance, an opaque tone that does not partake of the real color of the glass but rather of that of the neighboring colors, in accordance with their radiating properties."

WINDOW, ST. MARK'S CHURCH, FRANKFORD, PHILADELPHIA, PA.
THE D'ASCENZO STUDIOS

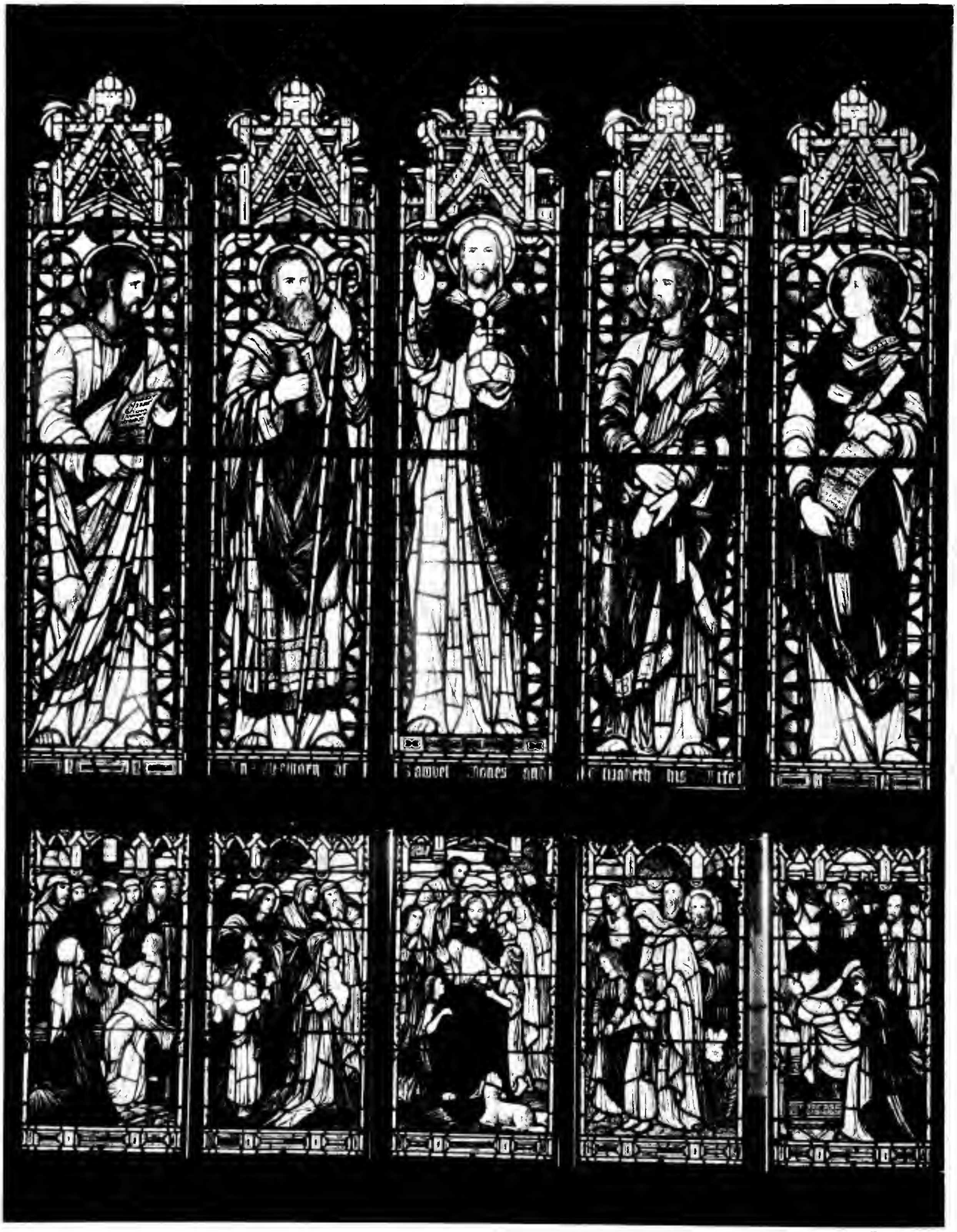
It seems curiously significant that, although the successful treatment of windows in strong light by the Old Masters in glass has long been appreciated by our traveled architects, students and interested laymen, no such simple statement of obvious facts as that quoted above seems to have been well circulated among the American artists in glass up to a comparatively recent time.

The realization that strong light is a glory they may utilize nobly, rather than a force they must painfully neutralize and curtain, is dawning upon our "glass men," and this is the most promising of all the hopeful signs within the craft today.

It is now more generally felt that windows are designed to admit light and that whether they face the splendor of our mid-day sun, or have a less intense north light, the principle remains the same. The consideration of pictorial possibilities is no longer allowed entirely to displace the artist's allegiance to this principle. There remains little question but that transparent colored or white glass (painted, as we have noted, so that the light is "stopped down" but not obscured in heavy masses), is the logical medium to use in the making of stained and painted glass windows.

This glass in sheets is known as "antique," and the better grades of it are made in England, as are also the lustrous "bottle glass" and "Norman glass," to which we have referred. Happily, owing to the tendency toward radiation, these glasses, when painted in spots or lines, rather than in tones or masses, gain in vitality and in depth and richness of color as the light is intensified.

So marked is this tendency that a win-



DETAIL OF CHANCEL WINDOW, ALL SOULS' CHURCH, BANGOR, ME.

MESSRS. CRAM, GOODHUE & FERGUSON, *ARCHITECTS* DESIGNED AND EXECUTED BY MR. C. J. CONNICK

ST. THOMAS A BECKET. FROM THE WINDOW IN BEAUCHAMP CHAPEL, WARWICK, XV CENTURY
DRAWN BY CHARLES J. CONNICK

dow in full color, heavily painted, when seen in a strong light, gives little suggestion of dull black in the heavy lines of dark neutral paint which have been fused into its surface. They, with the substantial leads and sturdy stay-bars are so influenced by the color radiation that their very blackness, greatly reduced in area, assumes the quiet lustre of intense dark color.

In relation to this fact, Viollet le Duc observes: "Transparent light devours so easily the opaque parts, such as the irons, leads and the heavy lineaments, that the painter must pay most careful heed to this phenomenon. On the other hand this influence of light cannot be counteracted by simply enlarging the shadows beyond measure, for then he only succeeds in making dark spots which destroy the form instead of accenting it. However, in spite of this devouring faculty of light, the least line out of place, at

SKETCH FOR LEADED GLASS WINDOW—CHRIST HEALING THE SICK, ST. JOHN'S CHURCH, CYNWYD, PA.

variance with the form, shocks the eye more than it could do in an opaque painting; all of which demonstrates that in

FRAGMENT—SEVEN LIBERAL ARTS OF CHRISTIAN LEARNING, POST GRADUATE COLLEGE, PRINCETON

DESIGNED AND EXECUTED BY WILLIAM WILLET AND ANNIE LEE WILLET

painting on glass all lines, no matter how delicate, have their value. If they are correctly placed they can hardly be perceived, if they are placed contrary to the form they torment the eye."

Color-photography has brought forth this fact in a most convincing manner, and a successful transparency is most enlightening in its accurate record of color radiations in stained glass windows.

One of the most interesting chapters in the history of painted glass has to do with the reaction, evident late in the thirteenth century, to mark the protest against dark interiors which were inevitable when windows in full color were used throughout a church edifice.

The manner in which the response was

AISLE WINDOW IN OLD ST. MARK'S CHURCH, NEW YORK

EXECUTED BY HEINIGKE & BOWEN

made to the demand for more light again awakens our admiration for the craftsmen of that period. Although, a type of grisaille, entirely in white glasses, leaded in small pieces with little or no paint, was known early in the twelfth century, it remained for the artist of a later period to add bands and spots of pure color, so that it took its place logically in edifices containing important windows in full color, and was often used effectively as a coherent part of windows containing colored medallions and figures.

CENTRAL WINDOW OF APSE, LADY CHAPEL, LIVERPOOL CATHEDRAL

WINDOW, DESIGNED AND EXECUTED BY YOUNG & BONAWILS

One great secret of the beauty and effectiveness of grisaille is, of course, the strict adherence of its designers to the same principles of light and optics that marked their wonderful successes in the use of color.

On the field of varying tones of whites, the light is broken by flowing lines and by delicate lattices or hatchings, and the flashes of color, especially the reds and yellows, are left practically clear of paint.

It is a curious fact that this truly beautiful type of painted glass was, until recently, represented in America by crude examples done mechanically, and entirely lacking in the silvery lustre and charming bursts of color which distinguish the old-world grisaille. To-day many American churches are enriched by grisaille, wrought sympathetically in the exquisite textures consistent with its highest possibilities, and painted with due regard for varying intensities of light.

Its cost is so moderate that, in many instances, a type of it is used for temporary glass, and thus the violent glare, so distasteful to architect and layman, is most pleasantly avoided.

It is not within the range of this article, if indeed it be possible in any form of expression, to define the enduring beauty and charm of a worthy achievement in stained and painted glass. As well attempt to

"*Write in a book the morning's prime*
Or match with words a tender sky."

Its great, if not its greatest distinction lies in color; and certainly no rules thus far formulated have furnished the subtle guiding influences which would produce, through cool intellectual processes, the glow and thrill of a true color composition.

WINDOW, CHURCH OF THE HOLY FAITH, LOS ANGELES, CAL.

EXECUTED BY JAMES FREDERICK RUDY

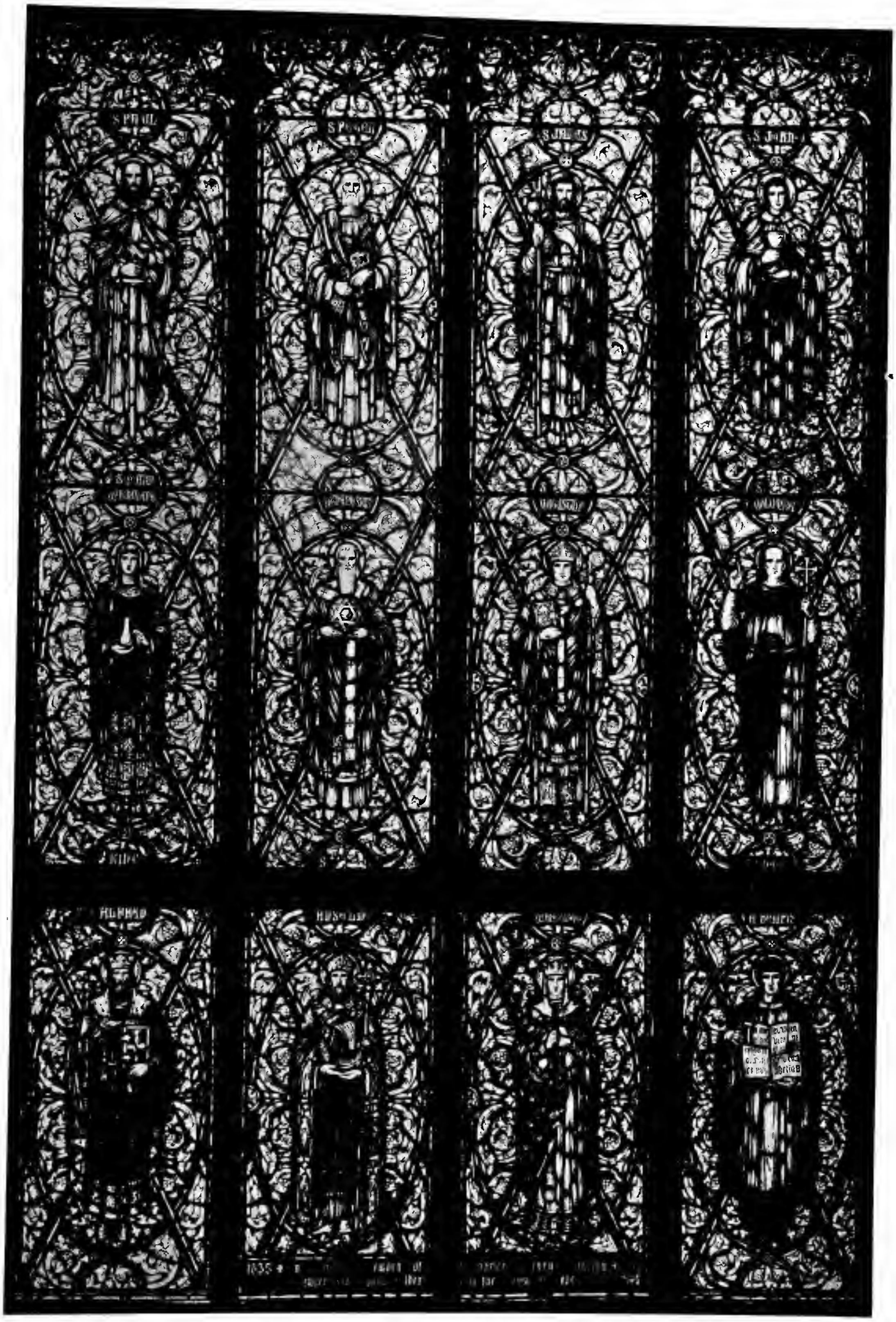
The tendency to copy faithfully the work of the early masters does not lead necessarily either to sure success or to certain failure. Many windows of genuine charm have so closely followed mediæval types as to be frankly archeological in their most direct appeal. There is much to be said for such windows, especially at this time when the true dignity of composition in lead and glass is only beginning to be broadly appreciated.

It is essential to revert to early schools of window-making, not primarily to copy drawing or composition (although a knowledge of both is necessary), but rather we are inspired by the discovery that, in their acceptance of the broad principles on which the craft is founded, they were unswervingly right, and that they were creative artists of wonderful distinction and power.

It is the lofty spirit that inspired the artists of old, vivid and vital in its inspiration, that we would reveal to all who are interested in the craft.

Architects who are sincerely striving to build and enrich enduring structures will find this spirit struggling for expression, and at times bursting forth most radiantly even through the many discouraging conditions so evident today.

It is sure to prevail eventually among us as it has always prevailed among lovers of beauty and its expression in inspired handicraft, throughout the centuries.



HOUSE OF HOPE PRESBYTERIAN CHURCH, ST. PAUL, MINN.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

LANCETS OF TRANSEPT WINDOW IN GRISAILLE, WITH FIGURES OF SAINTS IN FULL COLOR. (BIGELOW MEMORIAL WINDOW.)

DESIGNED AND MADE BY CHARLES J. CONNICK

This window is remarkable for the lustrous silvery tones of the Grisaille, which are interspersed with bands and spots of jewel-like color. These color motives are taken up in larger masses by the figures and the whole affords an illumination in warm and silvery lights.

THE DEVELOPMENT OF THE GOTHIC APSE

By LEWIS W. SIMPSON, F.R.I.B.A.

HOW often one finds that a modern gothic church has been spoilt by an apsidal chancel, yet this may have been the express wish of the client, and in direct opposition to the architect, who has probably condemned it as out-of-date, undignified, etc., in comparison with a rectangular treatment! Of course in the case of a cathedral, conditions are different as the apse has an ambulatory arcade, triforium and clerestory.

In this article I do not advocate the apse for a small church, I merely call attention to the possibility of its better treatment, and mention some interesting examples in England.

Truly it is old-fashioned, and in the present day usually very tamely treated, —a feeble reminder of ancient work. The old apse has a charm which the modern one does not possess. However, having an ancient form, it has at least some claim on our attention.

The apse was used in England in pre-conquest days, and afterwards still more so, under the influence of those who had known it so well on the continent; while the rectangular chancel was also used at the same early date, but not to so great an extent.

Its more early and Romanesque history we will not now consider, nor the numerous ancient gothic examples which exist in countries other than England.

ALTAR SCREEN IN AISLE OF HENRY VII CHAPEL, WESTMINSTER

Those who have seen the little church of Newhaven, Sussex (Fig. 1), with its semicircular apse, small windows, flat buttresses, and short sturdy tower, must be impressed with its compactness and quiet dignity. In plan (Fig. 2), the apse forms the sanctuary, and the tower the choir. Old Shoreham Church has a rectangular chancel and this too—in a different way—has its own charm. Both churches are of the early Norman period and in the same country.

Up to the middle of the twelfth century, all the choirs of the greater churches ended in a semicircular apse, with the exception of Dover, Southwell, Sherborne, and Romsey. At Norwich Cathedral (Fig. 3) and St. Bartholomew's, Smithfield, London, we find good examples in the Norman period. After this the tendency was to build rectangular east ends to choirs and chapels, in fact, very soon the apsidal plan fell into disuse, both in cathedral and in church, though we find a few examples of it in each period.

At Canterbury Cathedral the choir and apse are in the Early English style, but it is a poor reminder of the magnificent French apse of that time. At Lincoln Cathedral in the same period, we find that the four apsidal chapels in the choir transepts are semicircular in plan. Again, at Westminster Abbey, we have the four Early English apsidal

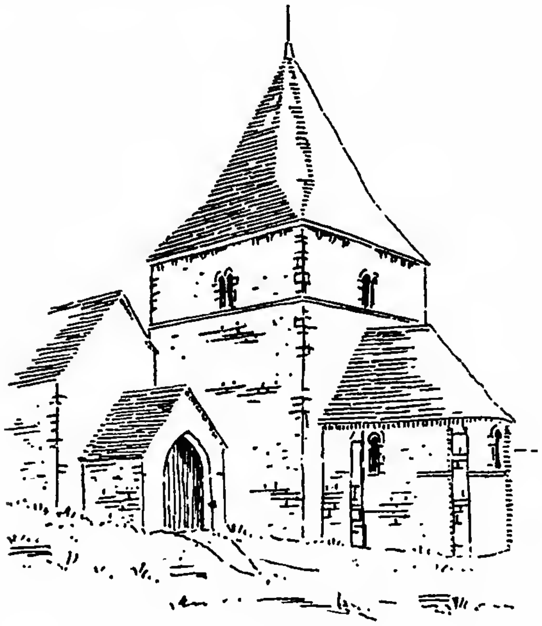


FIG. 1 NEWHAVEN CHURCH

chapels surrounding that of Edward the Confessor (Fig. 4); it is interesting to note the strong French influence here.

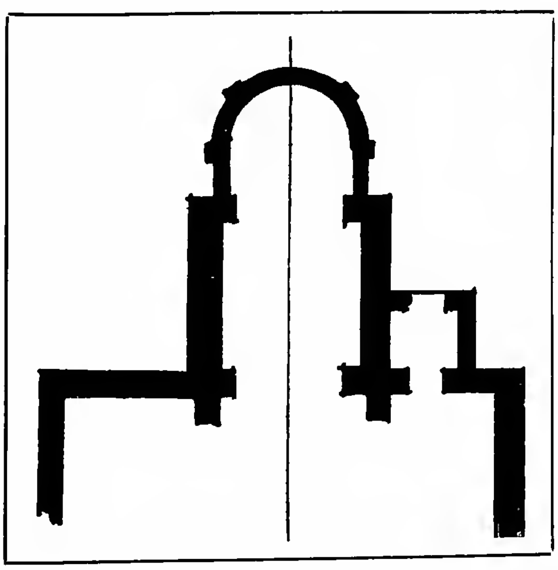


FIG. 2. NEWHAVEN CHURCH

For an example in the Decorated Period we can take the apse to the Lady Chapel in Wells Cathedral which is peculiar in plan (Fig. 5) but not particularly interesting.

At Gloucester Cathedral a wonderful transformation took place about the middle of the fourteenth century, when the Norman choir and presbytery were cased with Perpendicular work; at the same time the Norman apse was removed sufficiently to allow a fifteen-light east window to be built, which extended across the entire width of the choir. This window being raised on the walls of the ambulatory naturally followed the polygonal plan though somewhat flattened, and is of more than usual interest and beauty.

We have another example in all the glory of the Perpendicular style at Henry VII's Chapel, Westminster Abbey. Here we no longer find the acutely pointed roof which is a feature in the earlier work, but the prevailing flat one which is not

VIEW SHOWING DEFECT IN ORDINARY APSE. THE CENTRAL WINDOW LOOKS LOWER THAN THOSE ON EITHER SIDE

visible above the parapet. The plan is of great interest, for in earlier times the chapels radiated from the apse—as in Fig. 4—and were built outside the ambulatory; here, however, the five radiating chapels are built inside what would otherwise have been the ambulatory. The aisles and chapels are lighted by large bay windows which have two distinct forms in plan, and it may be that the apsidal form generally—and also the plan of these windows—suggested the bay windows so often found at this date in the great country halls and manors,—such as South Petherton Manor House, the Deanery at

Wells (Fig. 7), Crosby Hall, London (Fig. 8), and others; whilst the influence of Henry VII's Chapel is even more strongly marked in the bay windows at Hengrave Hall, and Thornby Castle. Figs. 9 and 10 show the plans of windows in this last building which should be compared with the bays at Henry VII's Chapel shown by Figs. 11 and 12.

The treatment of the walls in this famous chapel is very effective, especially the stone altar screens at the ends of the two aisles which are suggestive for modern work.

In St. George's Chapel, Windsor (Fig. 13), the interior of which is a fine example of Perpendicular work, we find apsidal *transepts* as well as chapels, and this is in itself an uncommon feature.

How is it that the great example at Westminster, the baptistry at Canterbury

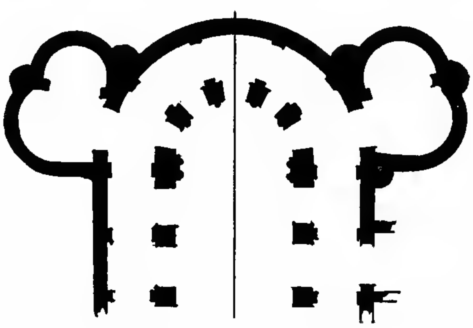


FIG. 3. NORWICH CATHEDRAL

Cathedral of the same period, and the wonderful bay of the Palais de Justice, Rouen, have not inspired modern architects to design more apses in the Perpendicular style which are really worth looking at?

As to the modern apse, one of the most successful examples I know of is at the College Chapel of St. Nicholas, Lancing, Sussex, designed by Mr. B. Ingelow, of London, who spent some time studying the French cathedrals beforehand. It is in the late Early English style, with a strong French influence, and the whole structure forms a really fine and imposing piece of work. The apse (Fig. 14) is flanked on each side by a tower, and these towers form the chief part of a wonderful whole. They do not rise higher than the parapet and so become part of the apsidal composition, breaking the long continuous sky-line, which is usually so uninteresting. Then again the buttresses have been most carefully designed, the architect evidently realizing how—in this high building—the sky would show up their outline.

Having spoken of the lofty apse, with its triforium and clerestory, let us now consider the low apse with

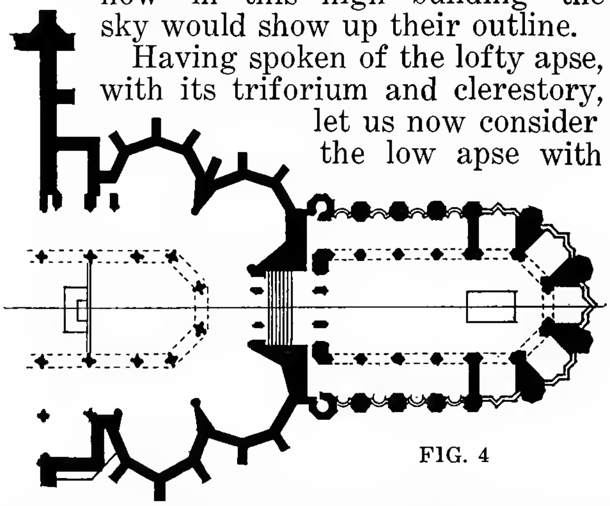


FIG. 4

CHAPELS OF EDWARD THE CONFESSOR AND HENRY VII, WESTMINSTER

only one tier of windows,—the ordinary church apse, semi-octagonal in plan. Its proportions are naturally lacking in the dignity possessed by the taller examples. Turning our attention first to the inside effect, we find that—by an

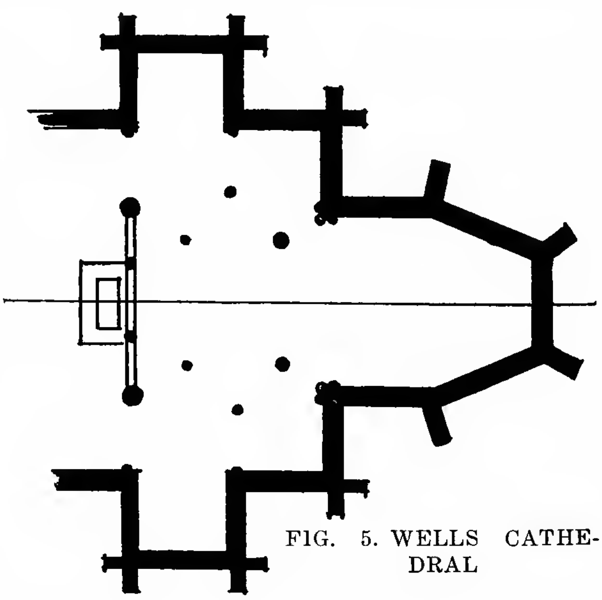
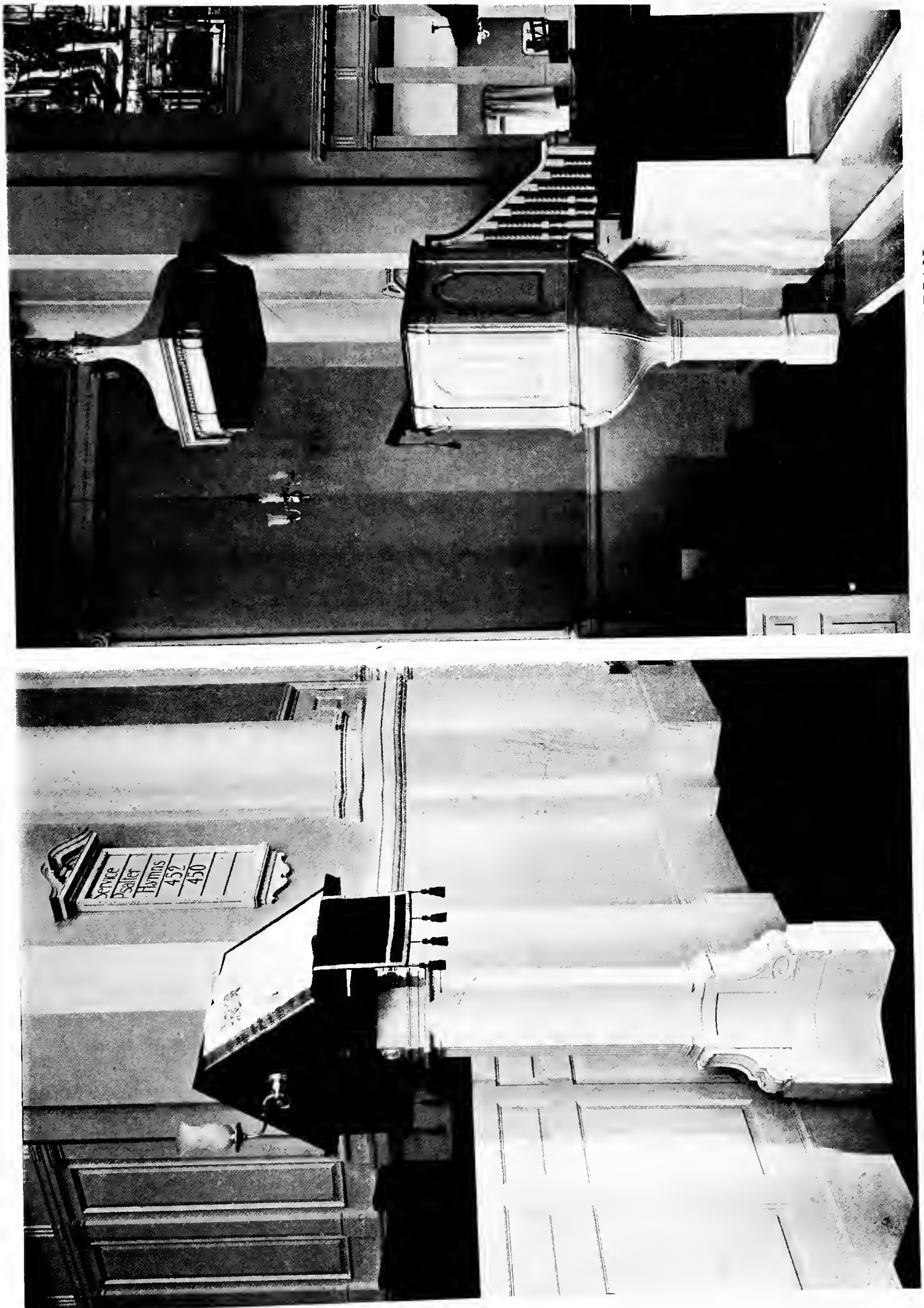


FIG. 5. WELLS CATHEDRAL

optical illusion—the cornice over the central window looks lower than that of the sides. The window under it



LECTERN AND PULPIT, THE SECOND CHURCH IN BOSTON, UNITARIAN
MESSRS. CRAM & FERGUSON, *ARCHITECTS*

is, of course, affected in the same way. The central east window being the most important should be the highest. The proportions of the apse are

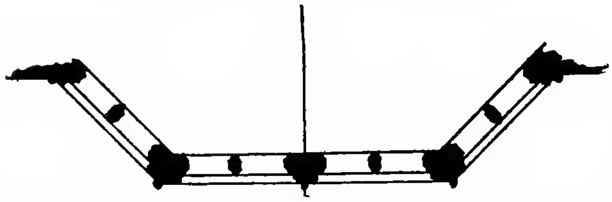


FIG. 7. THE DEANERY, WELLS

generally made worse by the roof being stained *dark*, thus cutting the height into two parts—as it were, instead of utilizing the roof—by keeping the color scheme one with the walls—to give apparent height.

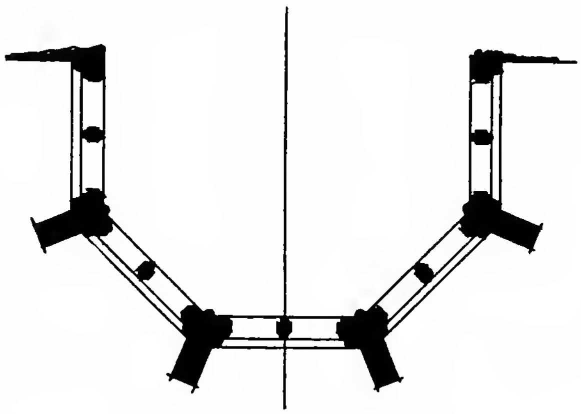


FIG. 8. CROSBY HALL

Of course this last effect is obtained when the roof is in stone as well as the walls. The arrangement also of the rafters—all radiating from the axis of the apse—is unpleasant, and reminds one of the inside

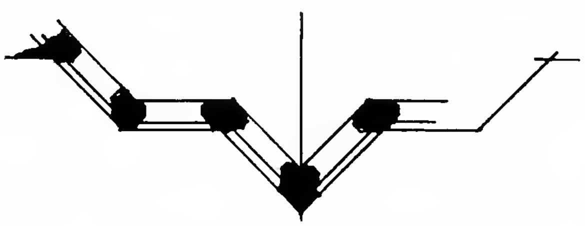


FIG. 9. THORNBY CASTLE

of a tent. Again, the window sills being low, the reredos must be low also, or it will block out a great deal of the central window, and in these days the tall reredos is in favor. But it is interesting to note an ancient example of the low reredos which is to be found at Exeter Cathedral in the Speke and Oldham Chantries. Here there is not much height, the east windows are low down, but underneath them are very fine specimens of ancient stone reredoses, with Perpendicular tracery and sculpture. The walls of these chantries are also richly traceried so that the reredos, walls, and screen form one harmonious design. But this is quite an exceptional piece of work.

The outside effect of the low apse is as undignified as the interior; at the eaves level there is a want of crispness in the line especially if there be no para-

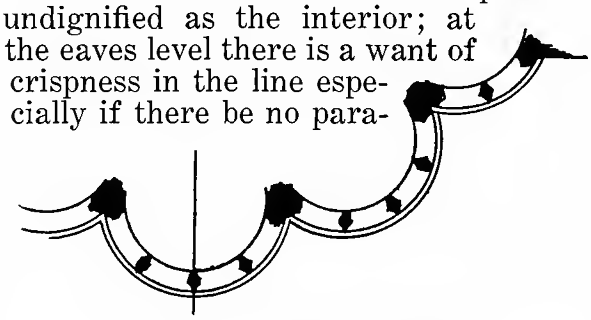


FIG. 10. THORNBY CASTLE

pet; one also feels the want of a gable at the east end to give greater height,—though with the Norman apse one is quite content, as this often has no long chancel attached, while the modern apse is spoilt by the necessary and longer chancel.

Now I will show a way in which these defects can be avoided and leave it to

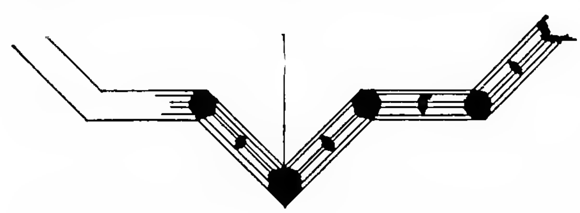


FIG. 11. CHAPEL OF HENRY THE VII

others to make such improvements as may occur to them. Some years ago I was asked to arrange the construction of the roof timbers for a little concrete church in one of the Fiji Islands; some

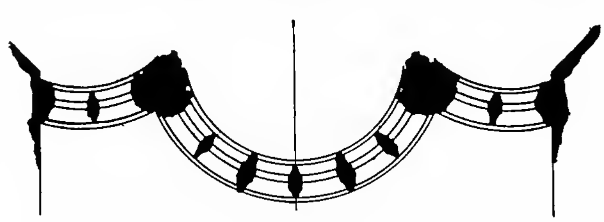
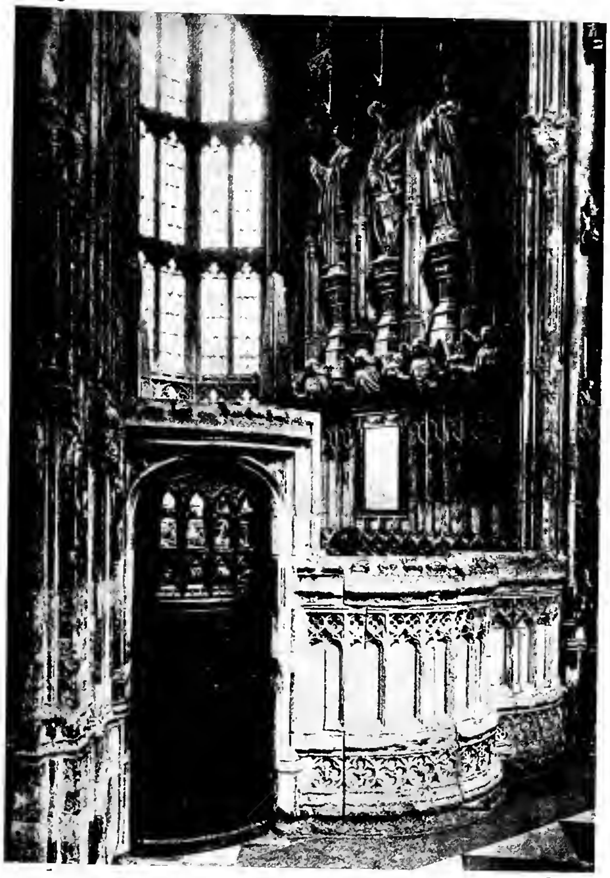


FIG. 12. CHAPEL OF HENRY THE VII



ALTAR SCREEN AND BAY WINDOW IN AISLE OF HENRY VII CHAPEL, WESTMINSTER

planters had started building it from their own designs, and when about eight feet up began to think how they should roof in the apse. They could not gather the rafters together in the usual way, as the angles of the semi-octagonal apse were

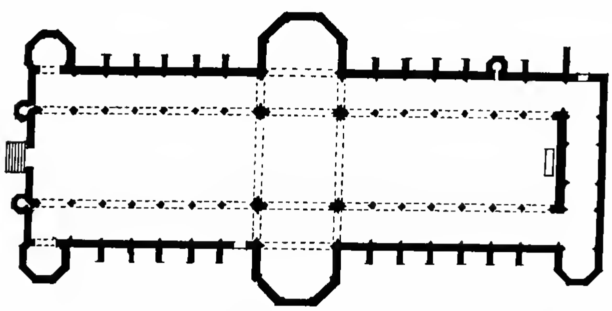


FIG. 13. ST. GEORGE'S CHAPEL, WESTMINSTER

not at forty-five degrees. After due consideration I solved this problem in—what I believe to be—a unique manner, and afterwards enlarged upon it when building a small church in Wiltshire, the photo of which will show how an apsidal plan can form the foundation for an effective and dignified structure. The ridge of the chancel is run straight through to a gable

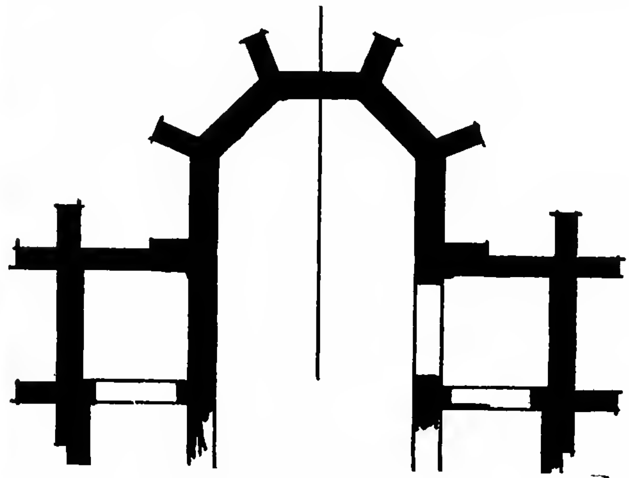


FIG. 14. LANCING CHAPEL

on the eastern face of the apse; the roof over the northeast and southeast faces is hipped back, and these two faces have

LANCING COLLEGE

A CHURCH IN WILTSHIRE

windows the same height as those in the sides of the chancel, but the eastern face —having a gable—is able to have three higher windows, without sacrificing the reredos to obtain them. Lofty buttresses run up the gable which is surmounted by a stone cross. This latter is far more effective than the metal one usually found on the ordinary apse. It may be noticed in Fig. 15 that the plan is not part of a true octagon; the eastern face being the widest, gives more room in the sanctuary.

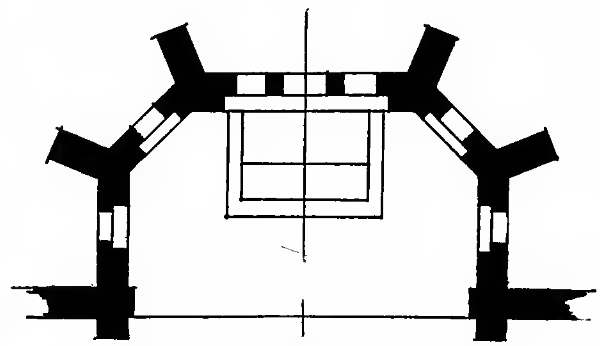


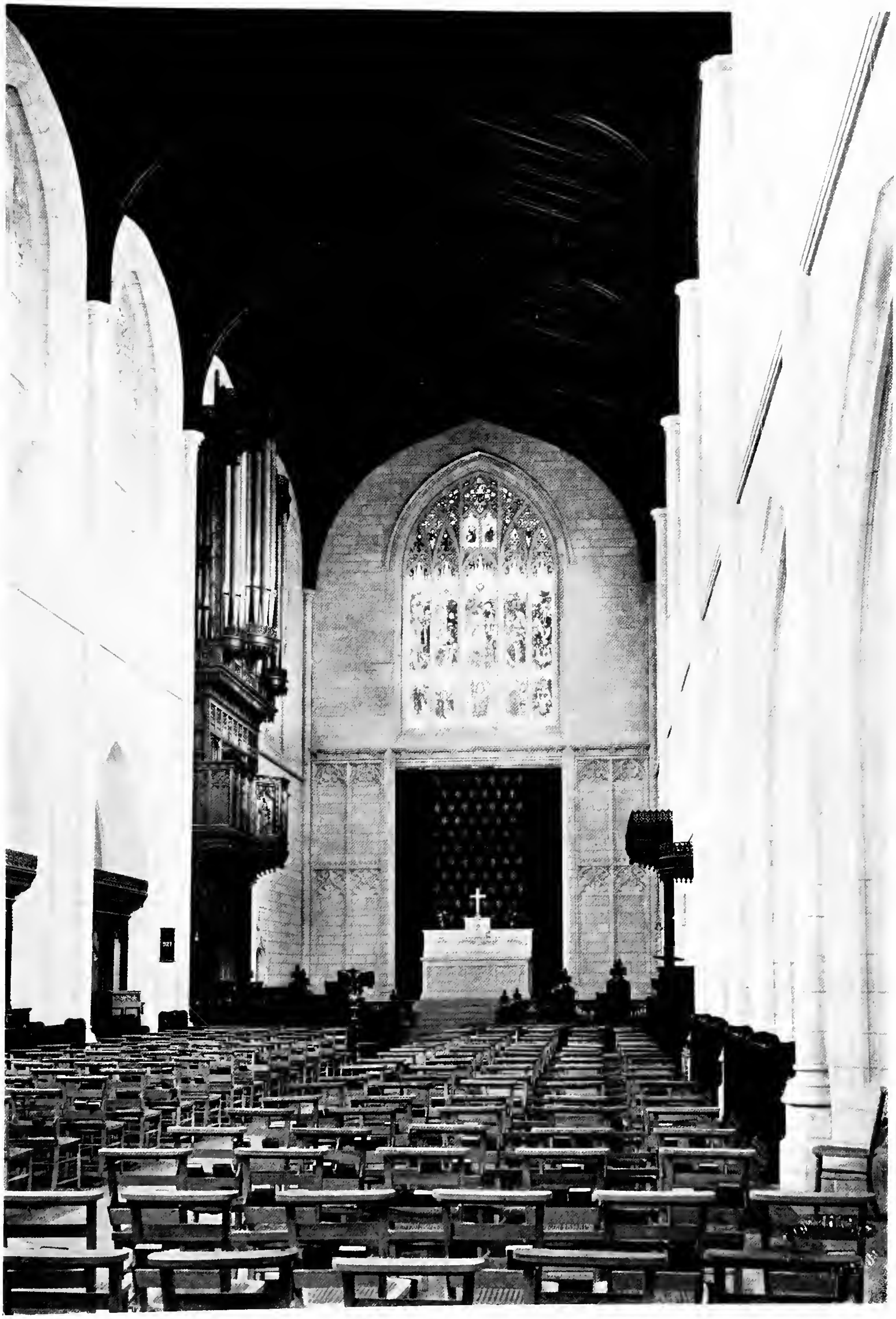
FIG. 15. CHURCH IN WILTSHIRE

I had to design this church in the Early English style as the funds were extremely limited; it would have been interesting to have built it in the Perpendicular style, with a large east window in place of the three lancets.

Plates

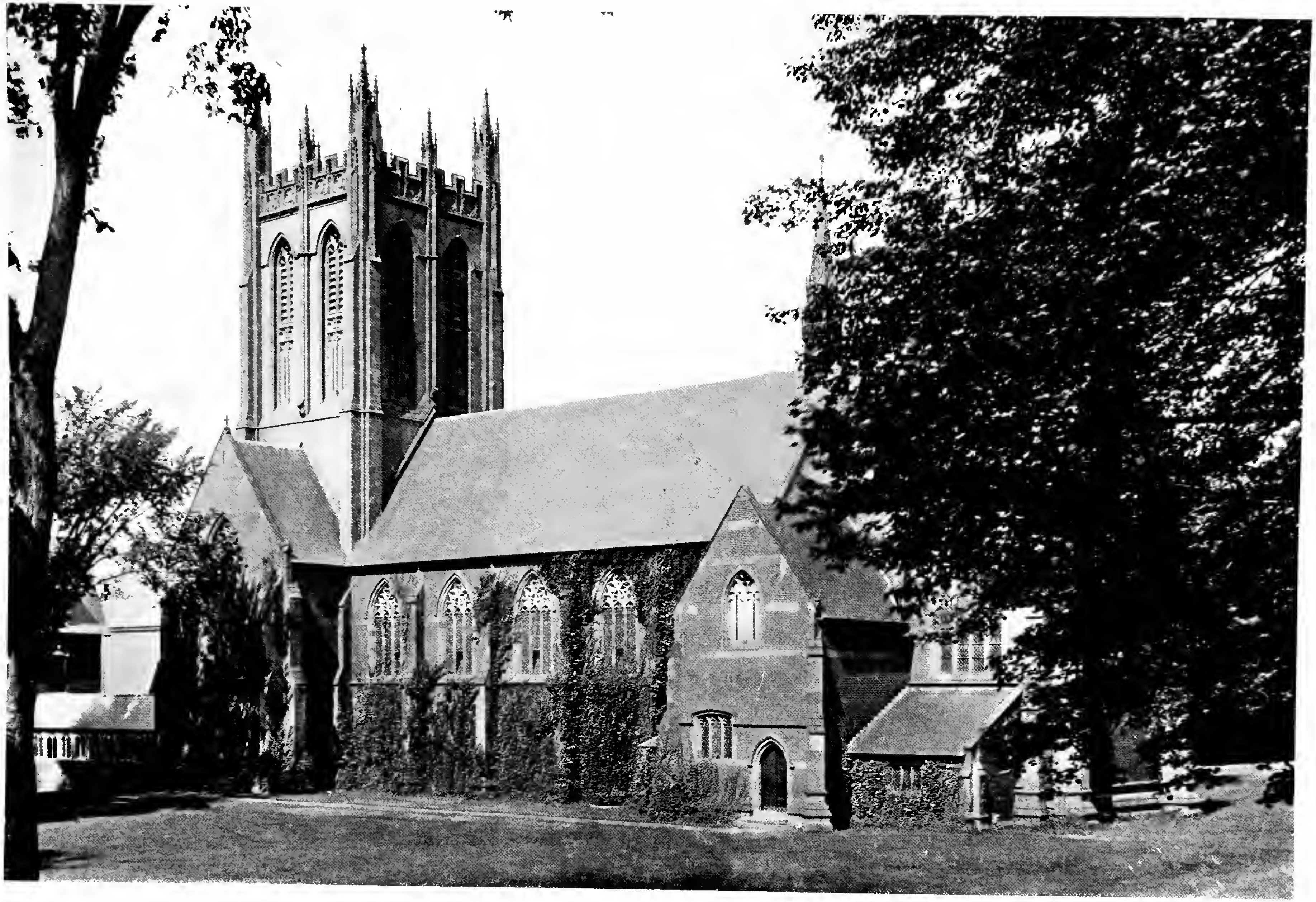
CHAPEL OF GROTON SCHOOL, GROTON, MASS.

MR. HENRY VAUGHAN, *ARCHITECT*



LOOKING EAST

CHAPEL OF GROTON SCHOOL, GROTON, MASS.
MR. HENRY VAUGHAN, *ARCHITECT*



CHAPEL OF ST. PAUL'S SCHOOL, CONCORD, N. H.
MR. HENRY VAUGHAN, *ARCHITECT*

Copyright by Kimball Studio.

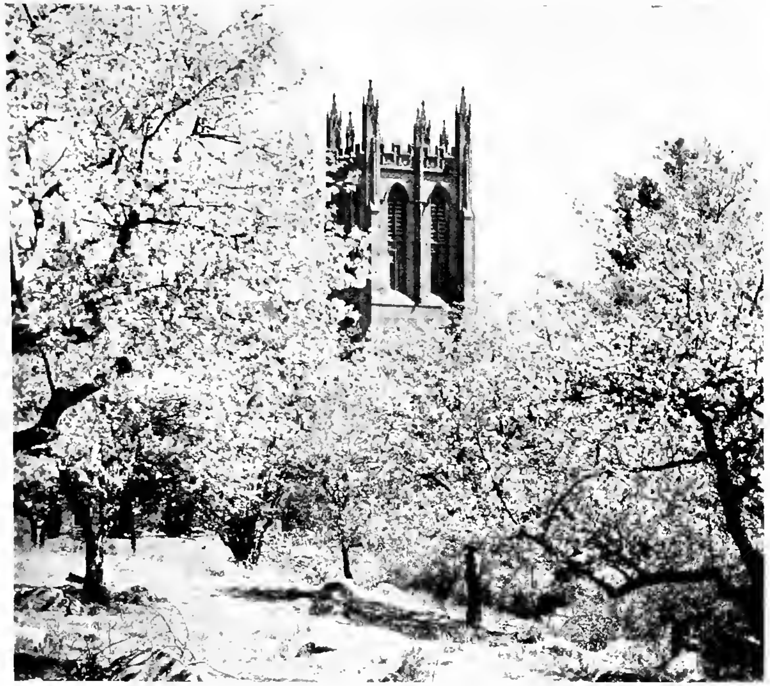
CHAPEL OF ST. PAUL'S SCHOOL, CONCORD, N. H.

MR. HENRY VAUGHAN, *ARCHITECT*

VIEW FROM THE ANTE CHAPEL

CHAPEL OF ST. PAUL'S SCHOOL, CONCORD, N. H.

MR. HENRY VAUGHAN, *ARCHITECT*



ST. PAUL'S SCHOOL CHAPEL, CONCORD, N. H.

GROTON SCHOOL CHAPEL, GROTON, MASS.

GROTON SCHOOL AND CHAPEL, GROTON, MASS.

MR. HENRY VAUGHAN

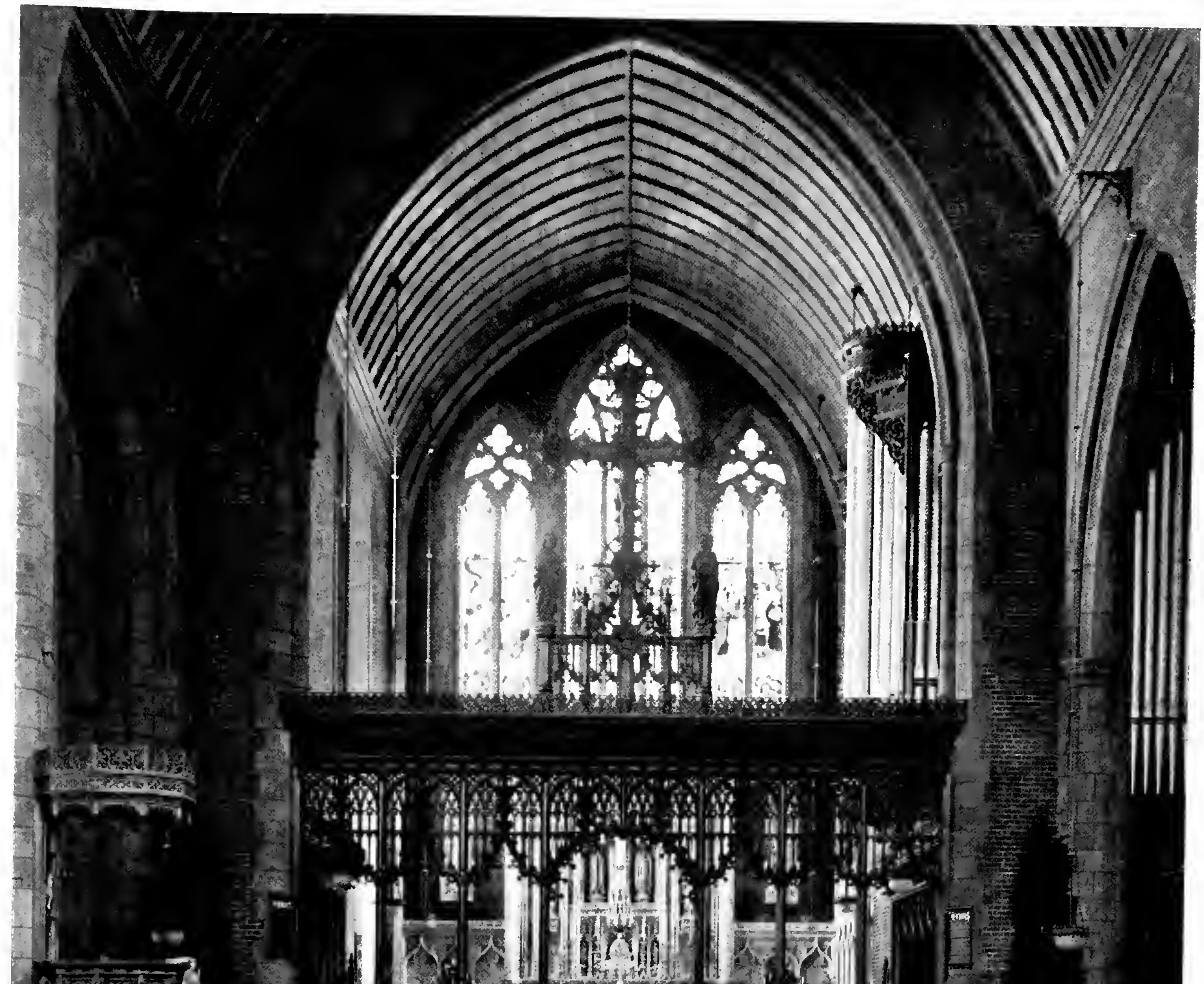
ARCHITECT

Photographs copyright by Kimball Studio.

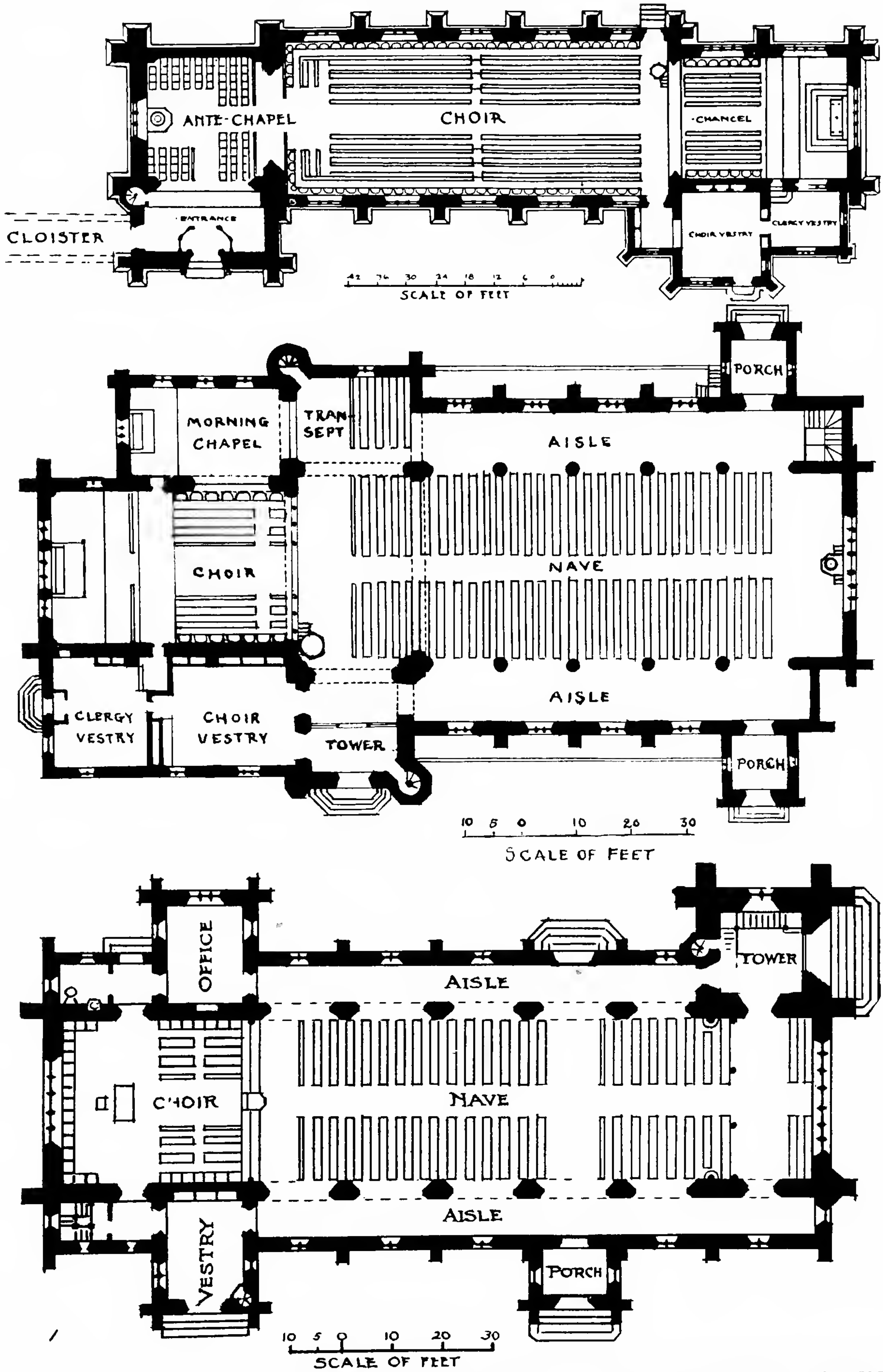
CHAPEL OF WESTERN RESERVE UNIVERSITY, CLEVELAND, O.
MR. HENRY VAUGHAN, *ARCHITECT*

CHAPEL OF WESTERN RESERVE UNIVERSITY, CLEVELAND, O.
MR. HENRY VAUGHAN, *ARCHITECT*

CHRIST CHURCH, NEW HAVEN, CONN.
MR. HENRY VAUGHAN, *ARCHITECT*



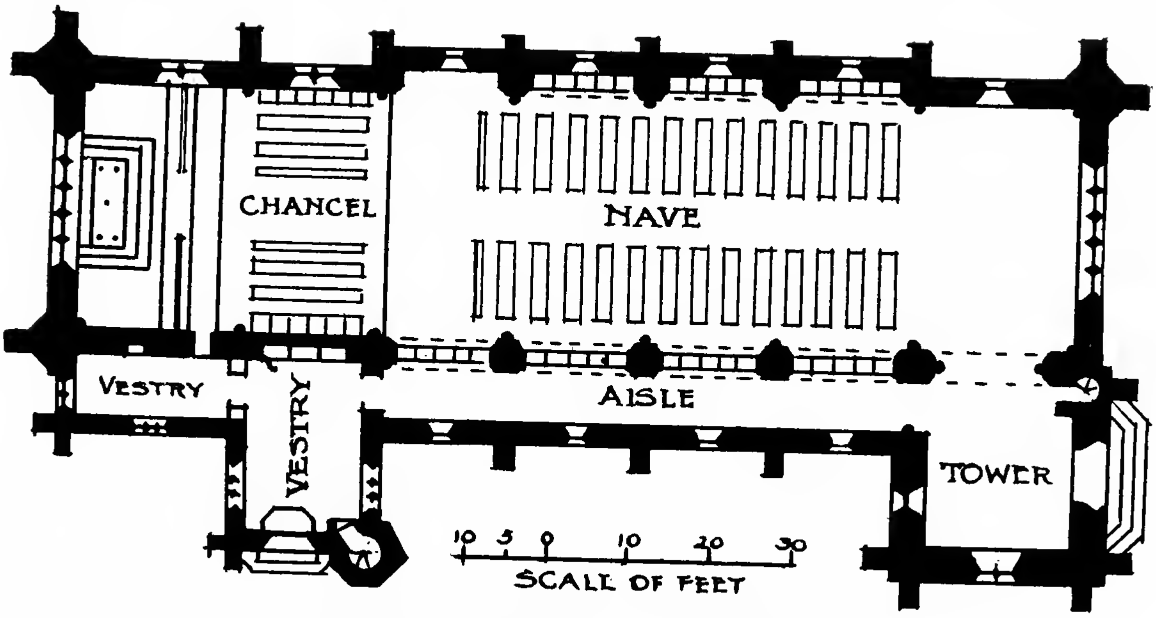
CHRIST CHURCH, NEW HAVEN, CONN.
MR. HENRY VAUGHAN, *ARCHITECT*



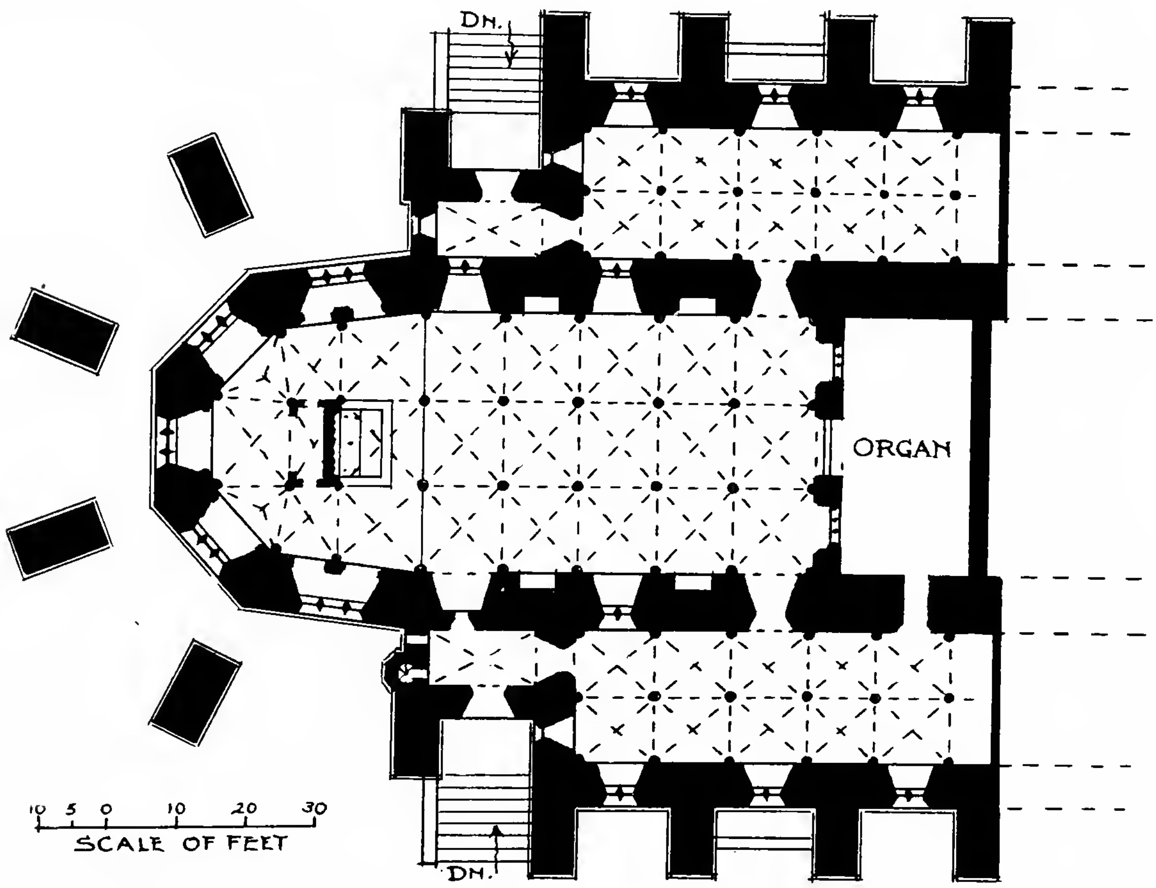
AT TOP—CHAPEL OF ST. PAUL'S SCHOOL, CONCORD, N. H. *IN CENTRE*—CHRIST CHURCH, NEW HAVEN, CONN. *AT FOOT*—CHAPEL OF WESTERN RESERVE UNIVERSITY, CLEVELAND, O.

MR. HENRY VAUGHAN, *ARCHITECT*

(For Illustration of These Churches See Preceding Pages.)



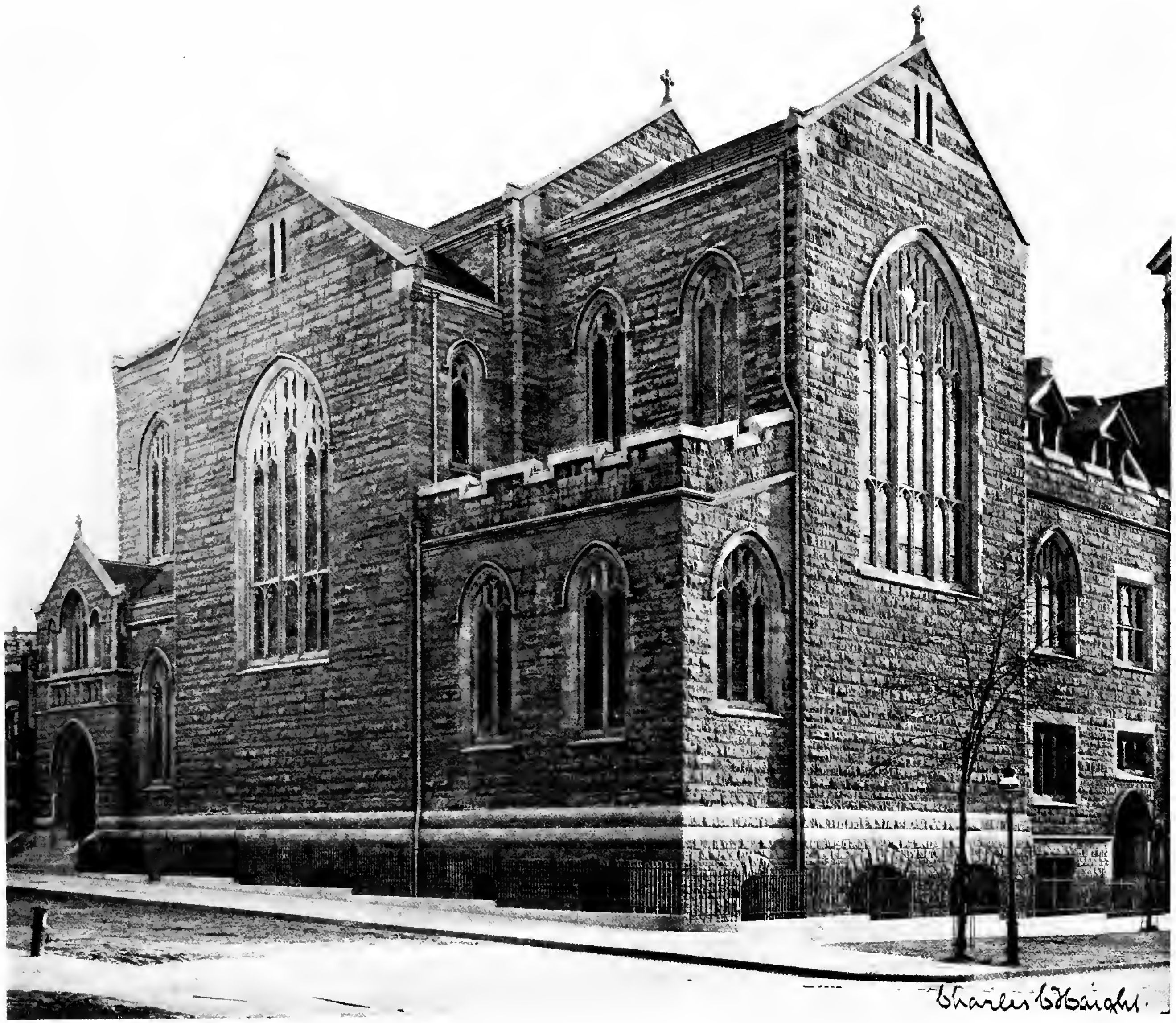
CHAPEL, GROTON SCHOOL, GROTON, MASS.

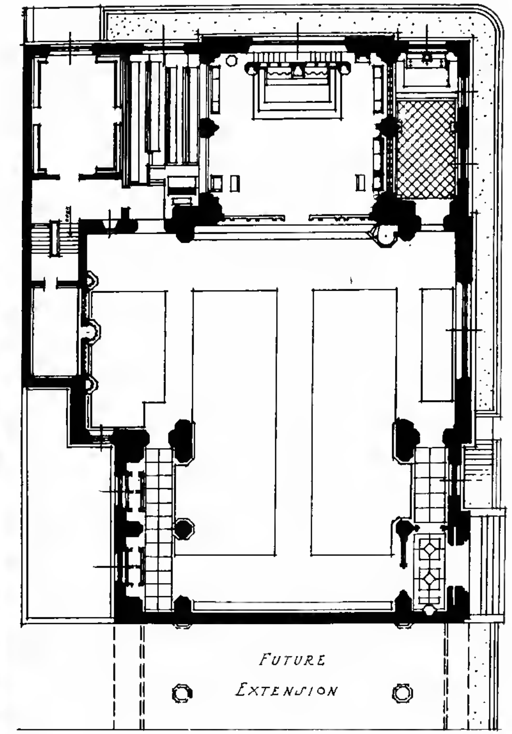


BETHLEHEM CHAPEL, CATHEDRAL OF SS. PETER AND PAUL,
WASHINGTON, D. C.

MR. HENRY VAUGHAN, *ARCHITECT*

(For Illustration of These Churches See Preceding Pages.)

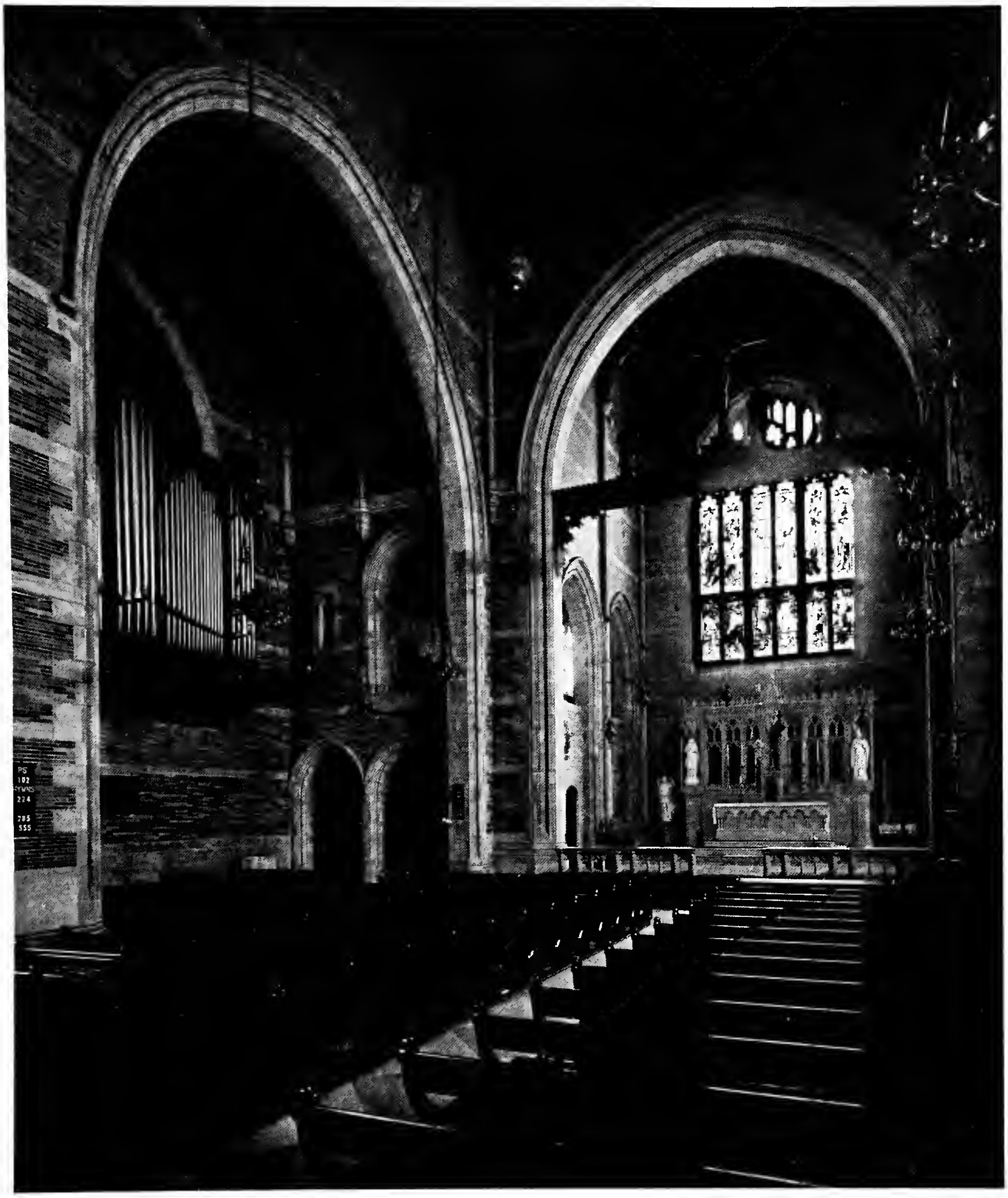




EXTENSION OF THE NAVE PLANNED FOR THE FUTURE—CHOIR OCCUPIES AN UPPER GALLERY SOUTH OF CHANCEL PROPER AND IS THEREFORE INCONSPICUOUS. LADY CHAPEL NORTH OF THE CHANCEL EXTERIOR IS OF GREY LIMESTONE.

ST. IGNATIUS CHURCH, NEW YORK

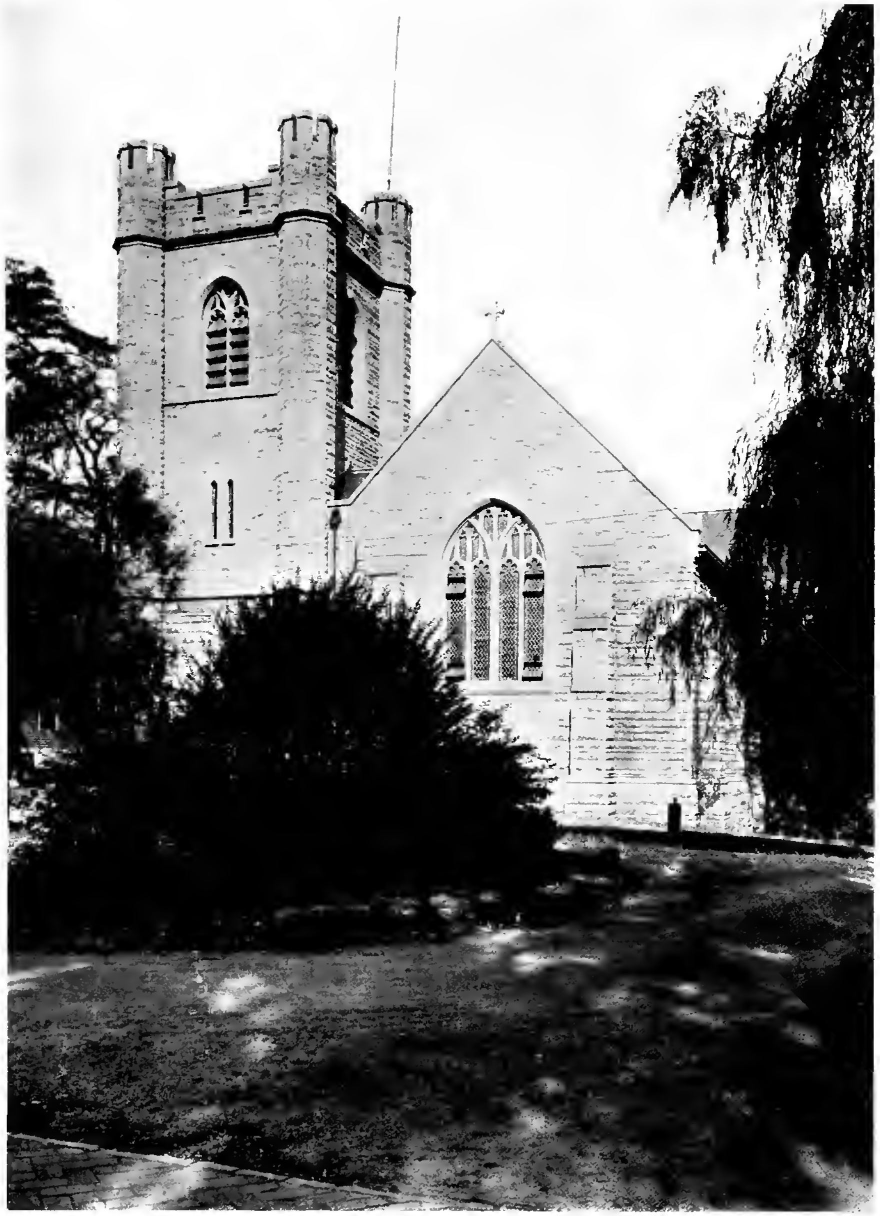
MR. CHARLES C. HAIGHT, *ARCHITECT*

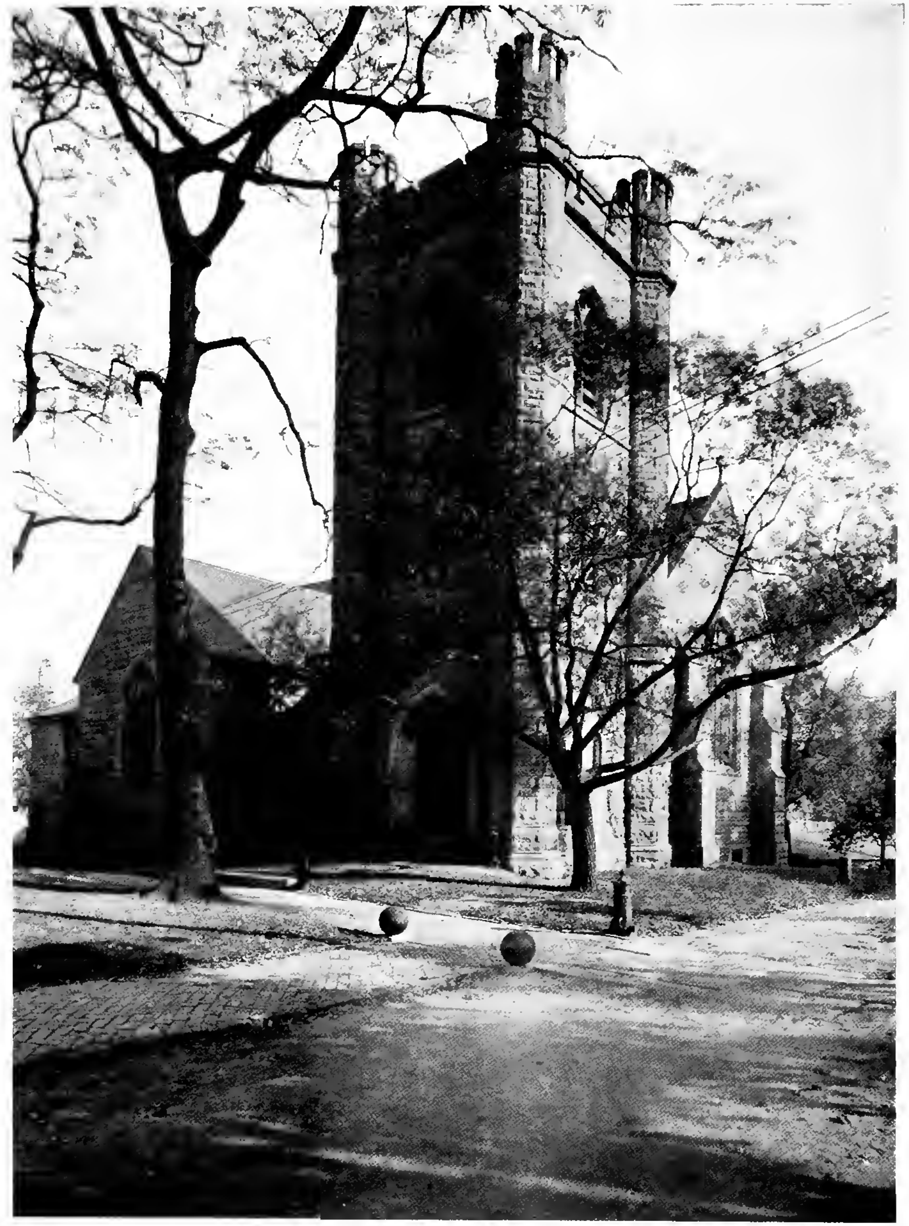


ST. IGNATIUS CHURCH, NEW YORK

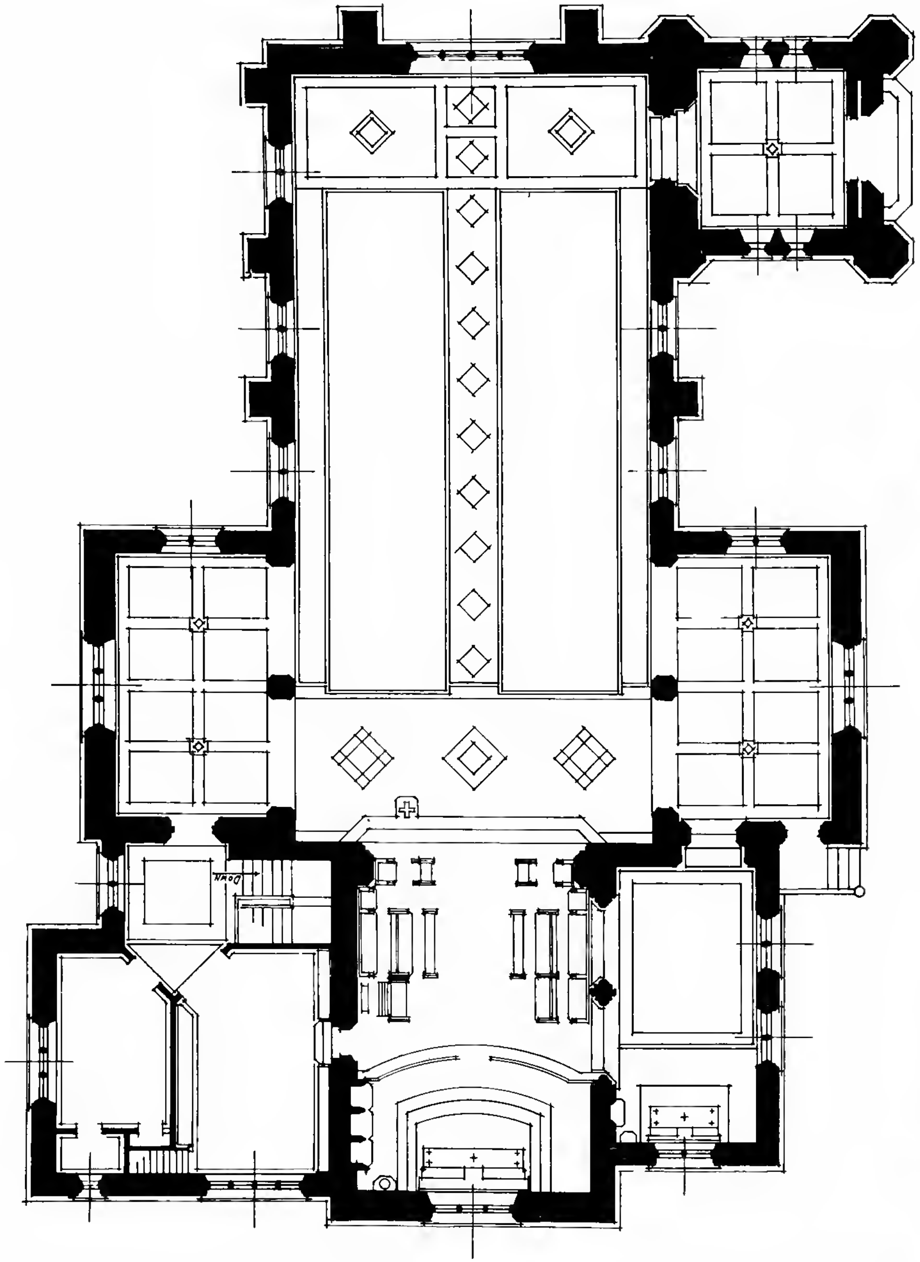
MR. CHARLES C. HAIGHT, *ARCHITECT*

BUFF PRESSED BRICK AND LIMESTONE, DARK PEWS AND ROOF-TIMBERS; ROOD-BEAM INSTEAD OF ROOD-SCREEN; UPPER CHOIR-GALLERY TO THE LEFT OF CHANCEL





ST. CORNELIUS CHAPEL, GOVERNOR'S ISLAND, NEW YORK HARBOR
MR. CHARLES C. HAIGHT, *ARCHITECT*

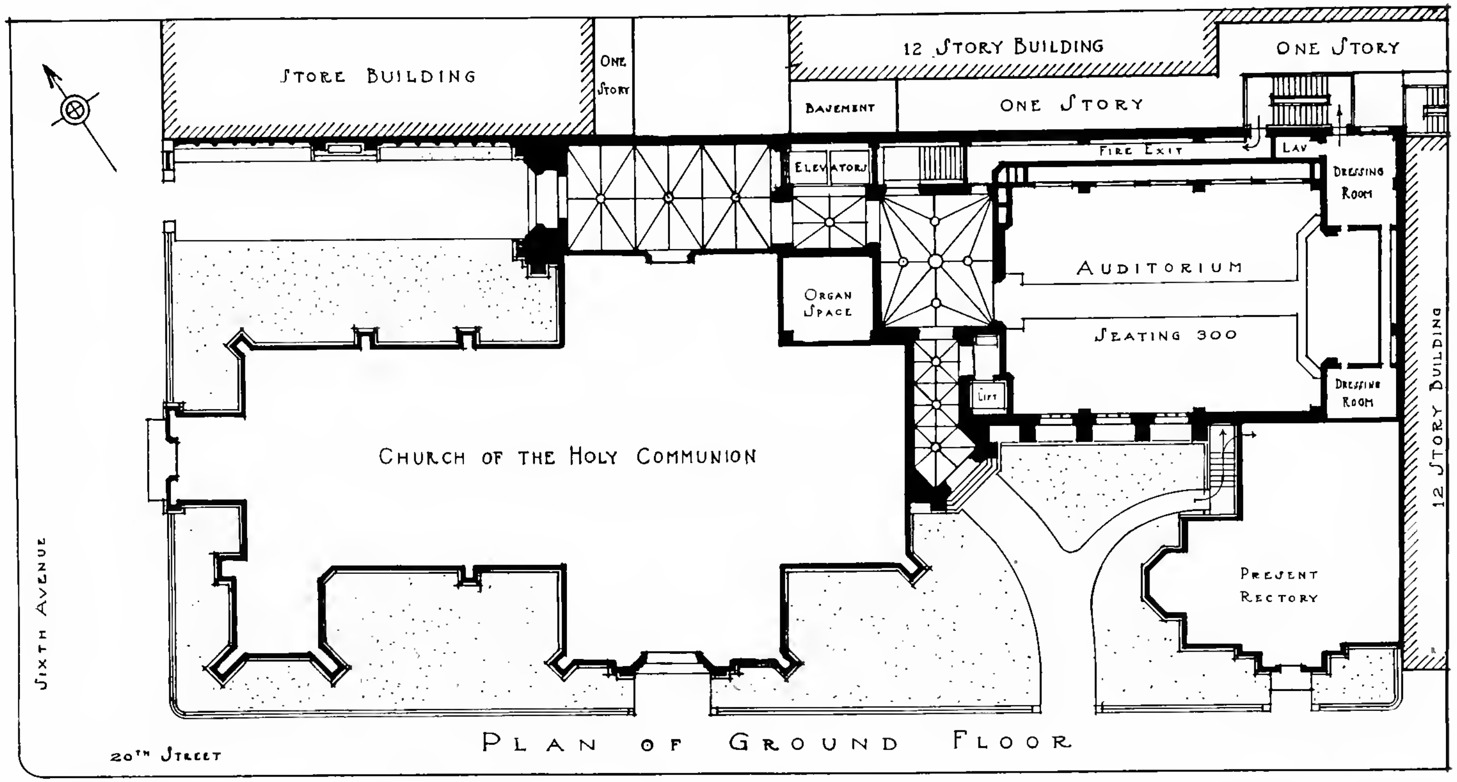


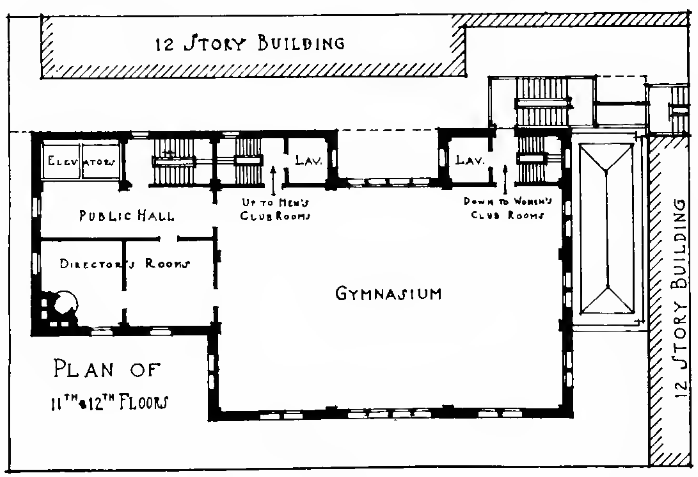
ST. CORNELIUS CHAPEL, GOVERNOR'S ISLAND, NEW YORK HARBOR

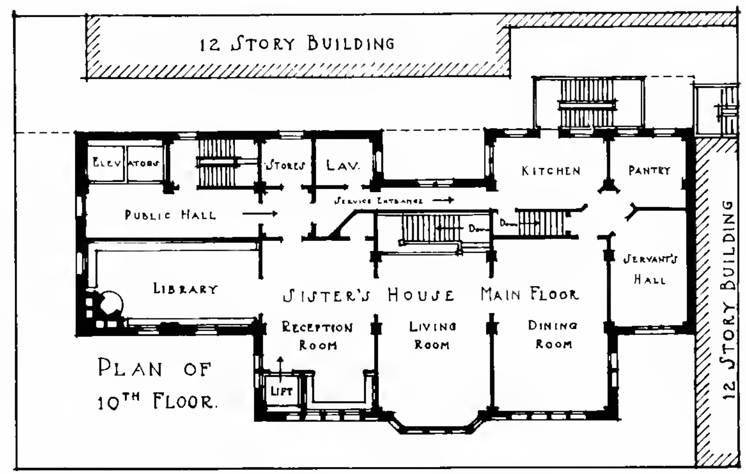
THE CHAPEL OF AN IMPORTANT UNITED STATES ARMY POST—SMALL CHAPEL NORTH OF THE CHOIR, VESTRIES ON THE RIGHT.

MR. CHARLES C. HAIGHT, *ARCHITECT*

PROPOSED PARISH HOUSE, CHURCH OF THE HOLY COMMUNION, NEW YORK
MESSRS. CHARLES C. HAIGHT AND GITHENS, *ARCHITECTS*



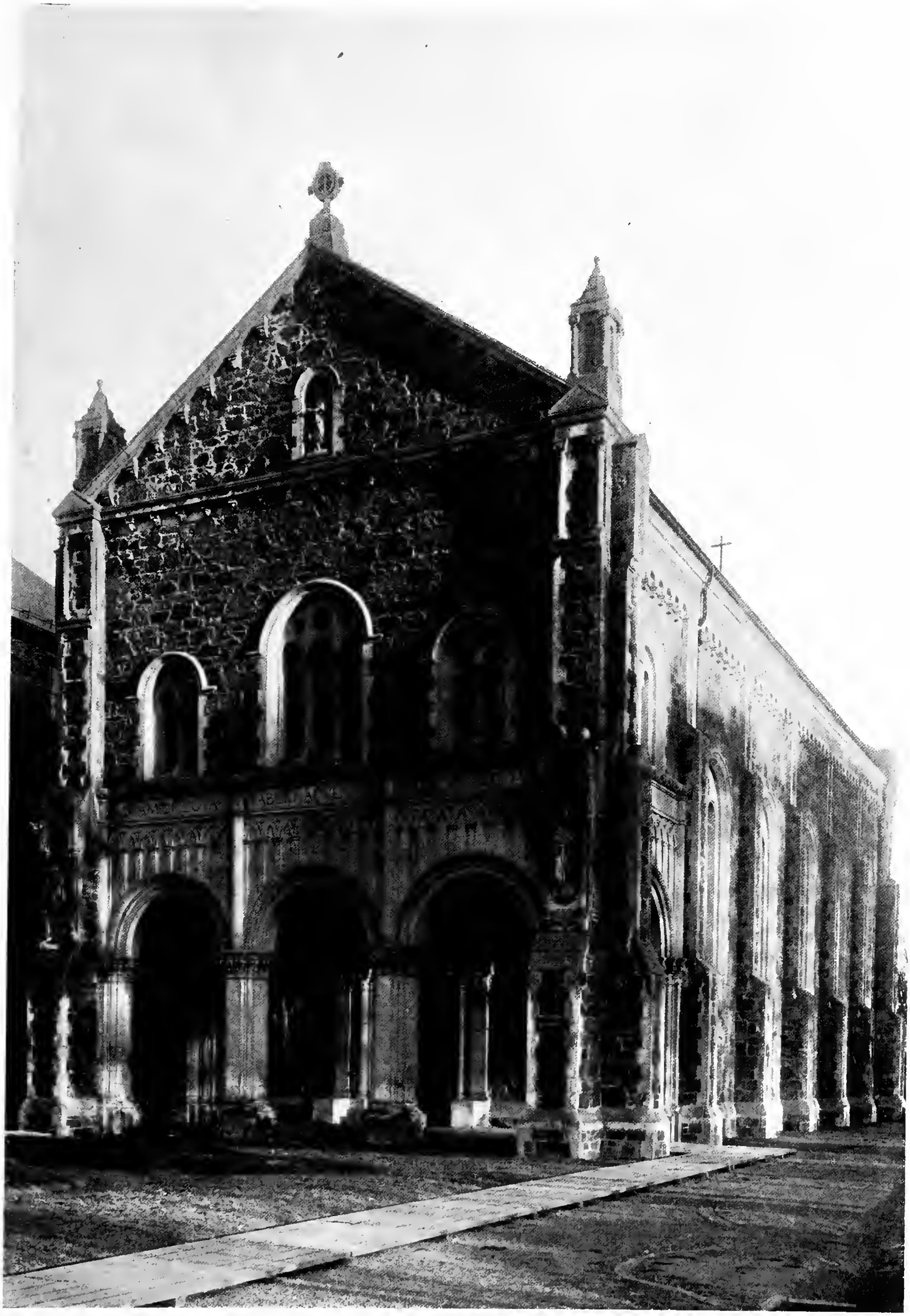




PROPOSED PARISH HOUSE, CHURCH OF THE HOLY COMMUNION, NEW YORK

MESSRS. CHARLES C. HAIGHT AND GITHENS, *ARCHITECTS*

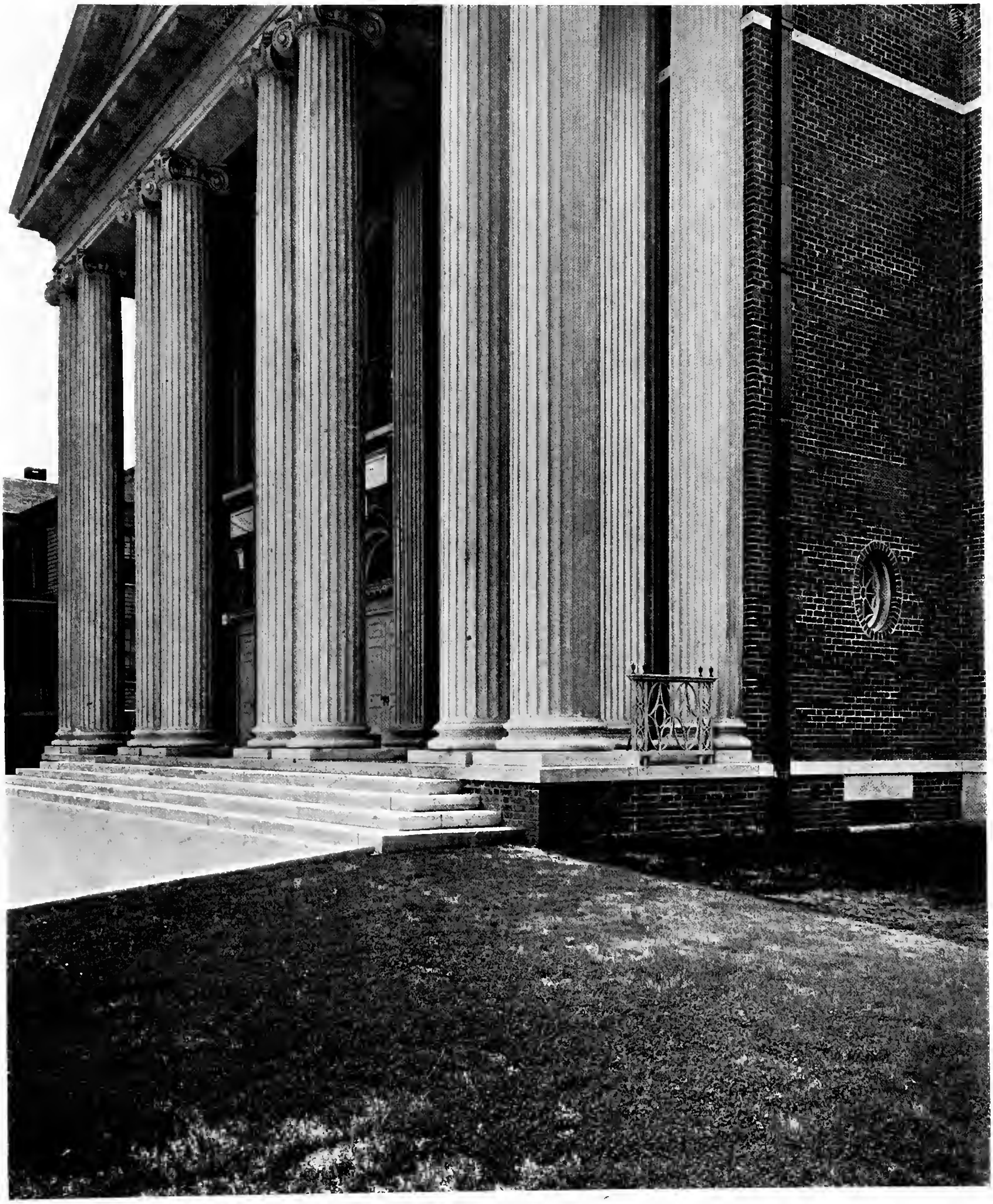
BUILDING TO HOUSE THE ENTIRE ORGANIZATION OF THE PARISH; PLANNED TO MAKE THE MOST OF UNOBSTRUCTED SOUTH AND WEST LIGHT, AS IT WILL BE HEMMED IN BY HIGH BUILDINGS TO NORTH AND EAST.



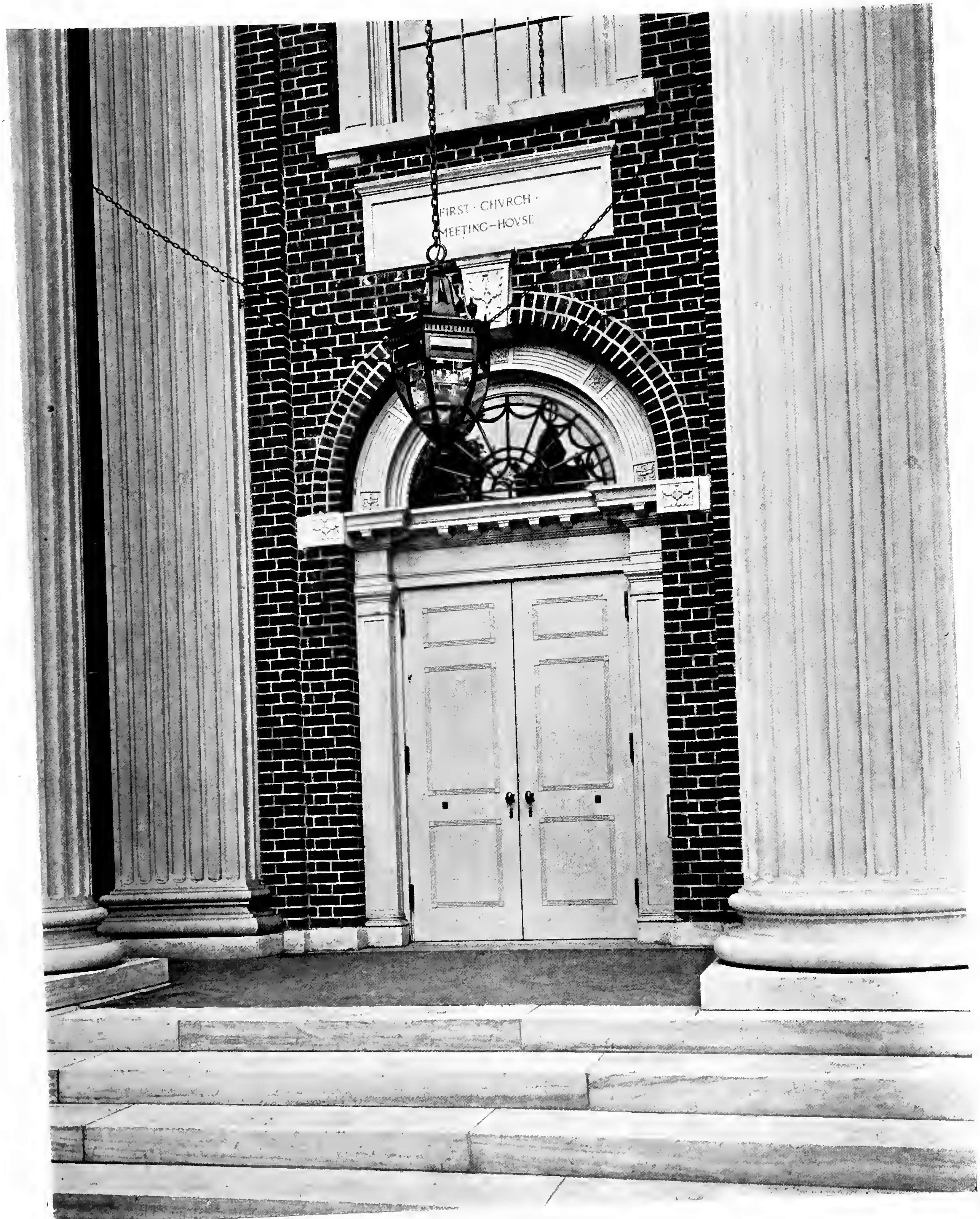
CHAPEL, ST. JOHN'S SEMINARY, BRIGHTON, MASS.
MESSRS. MAGINNIS, WALSH & SULLIVAN, *ARCHITECTS*

CHURCH OF OUR LADY OF THE PRESENTATION, BRIGHTON, MASS.
MESSRS. MAGINNIS & WALSH, *ARCHITECTS*

FIRST CONGREGATIONAL CHURCH, DANBURY, CONN.
MESSRS. HOWELLS & STOKES, *ARCHITECTS*
(See Article: The Development of the Meeting House)



FIRST CONGREGATIONAL CHURCH, DANBURY, CONN.
MESSRS. HOWELLS & STOKES, *ARCHITECTS*



DETAIL OF ENTRANCE

FIRST CONGREGATIONAL CHURCH, DANBURY, CONN.
MESSRS. HOWELLS & STOKES, *ARCHITECTS*

FIRST CONGREGATIONAL CHURCH, DANBURY, CONN.
MESSRS. HOWELLS & STOKES, *ARCHITECTS*

DETAIL OF SCREEN AT END OF BALCONY

FIRST CONGREGATIONAL CHURCH, DANBURY, CONN.

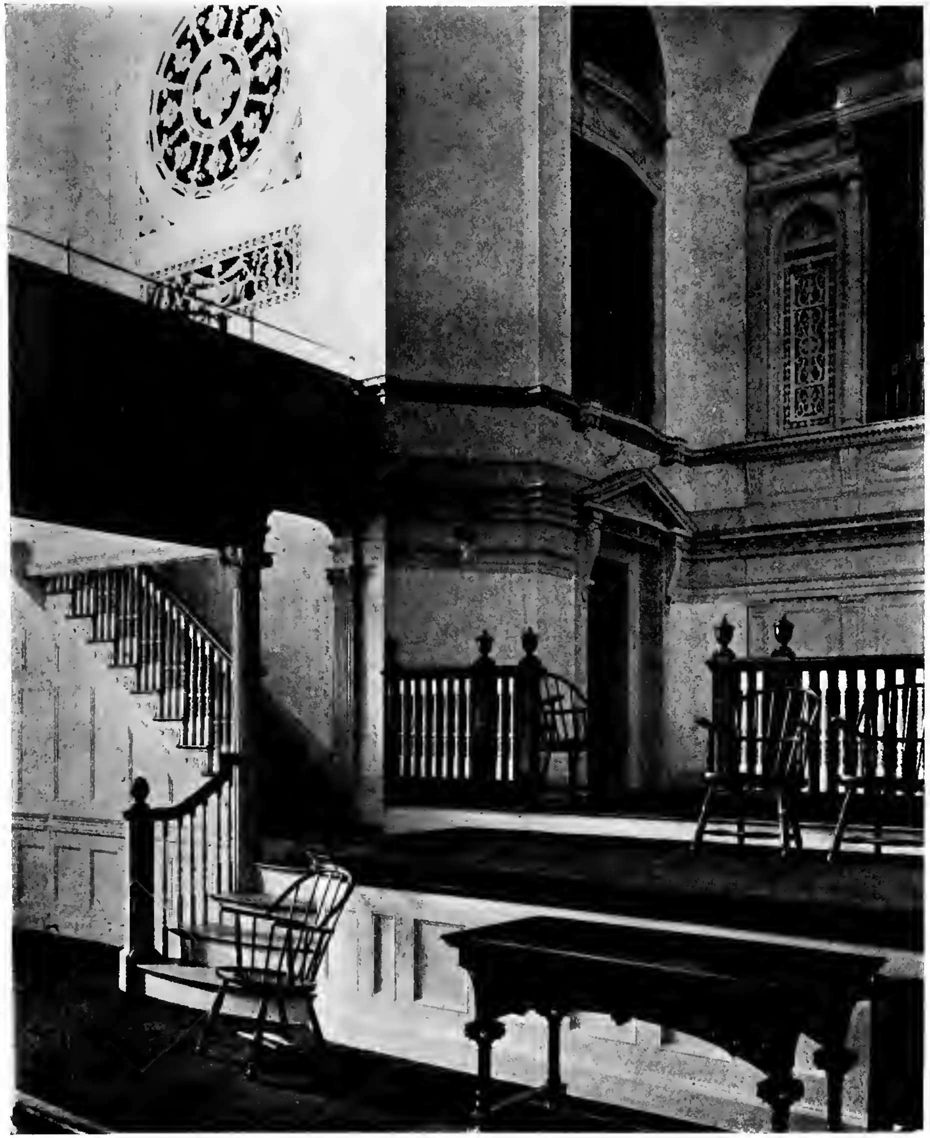
MESSRS. HOWELLS & STOKES, *ARCHITECTS*

THE PULPIT

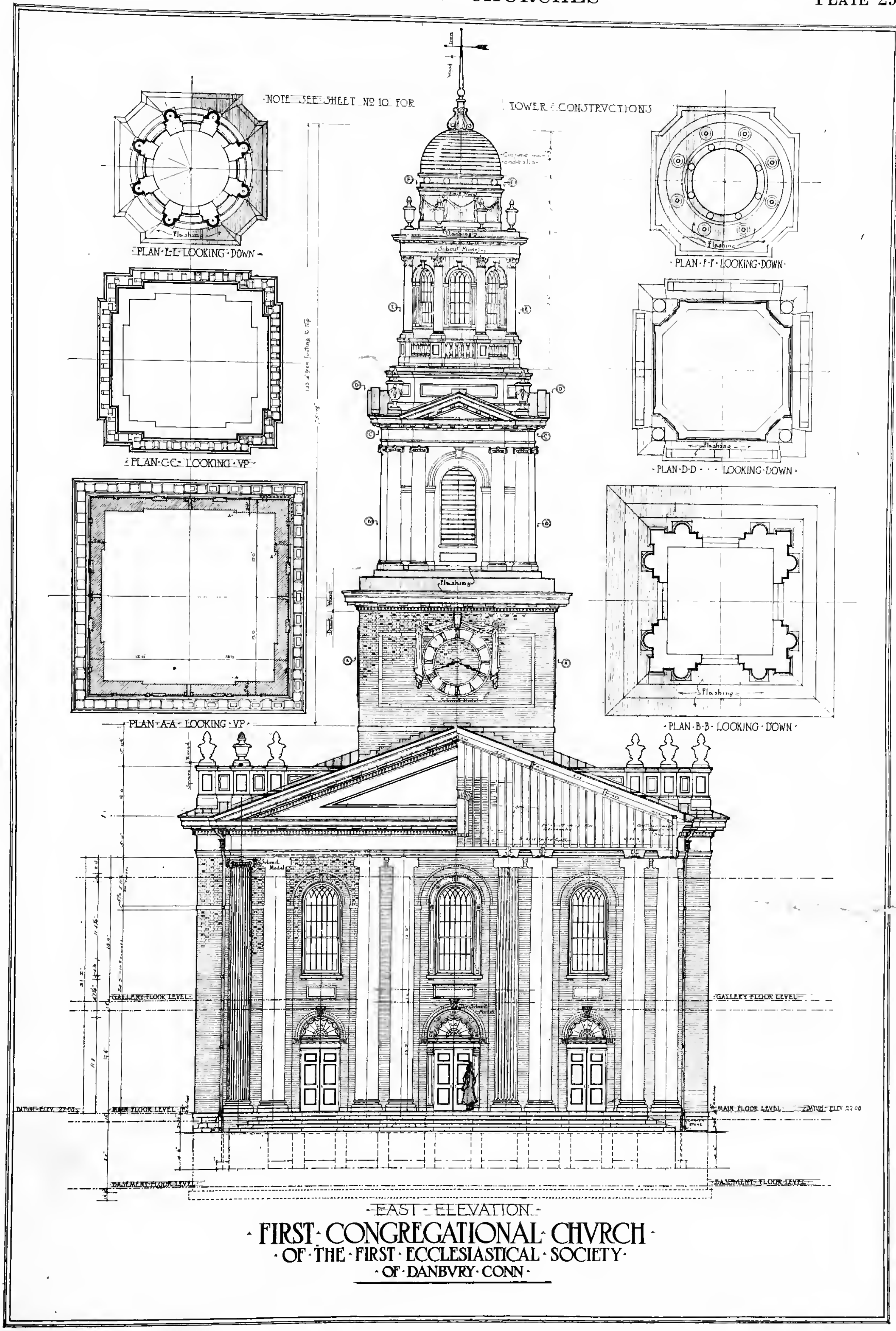
FIRST CONGREGATIONAL CHURCH, DANBURY, CONN.

MESSRS. HOWELLS & STOKES, *ARCHITECTS*

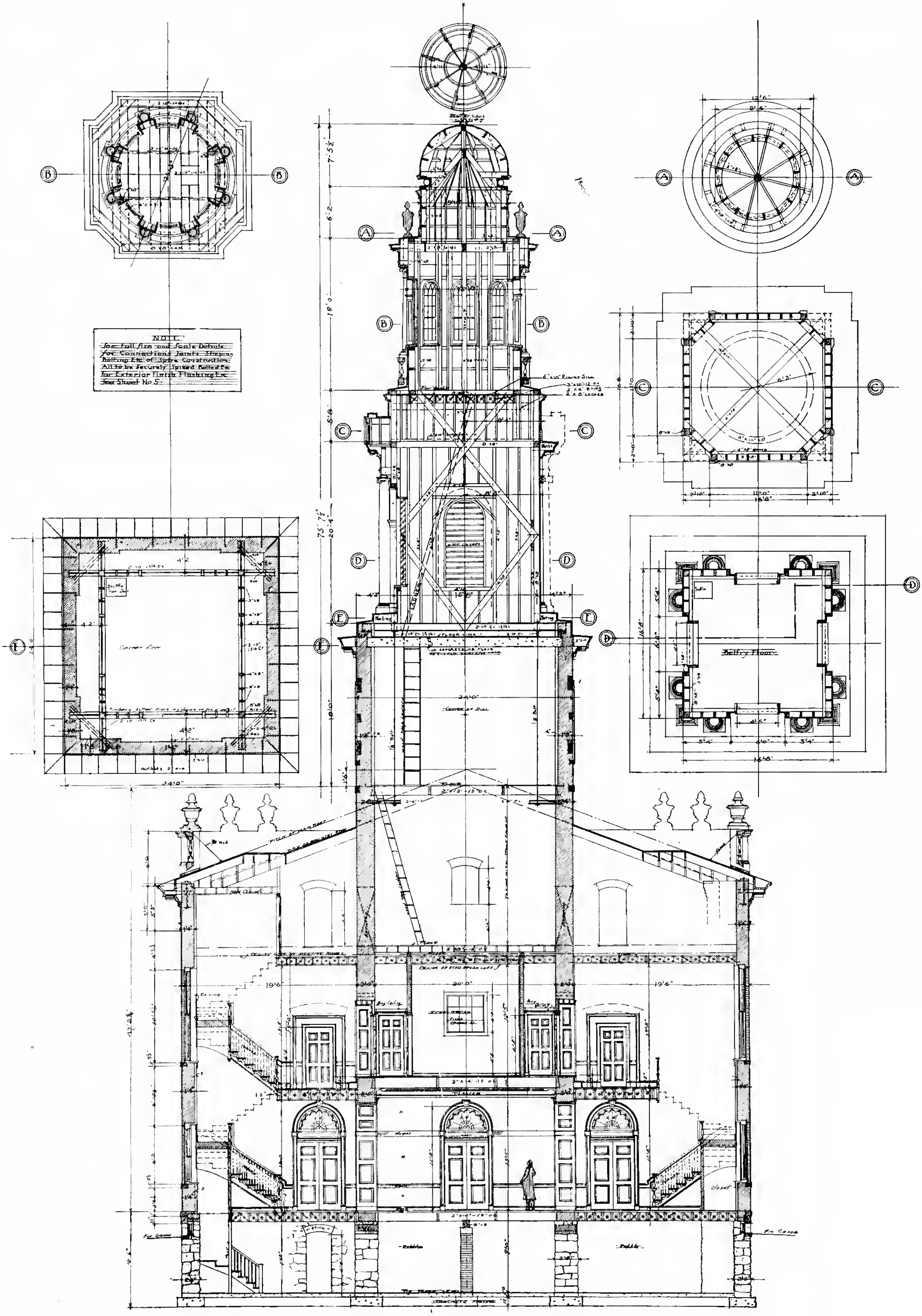
FIRST CONGREGATIONAL CHURCH, DANBURY, CONN.
MESSRS. HOWELLS & STOKES, *ARCHITECTS*



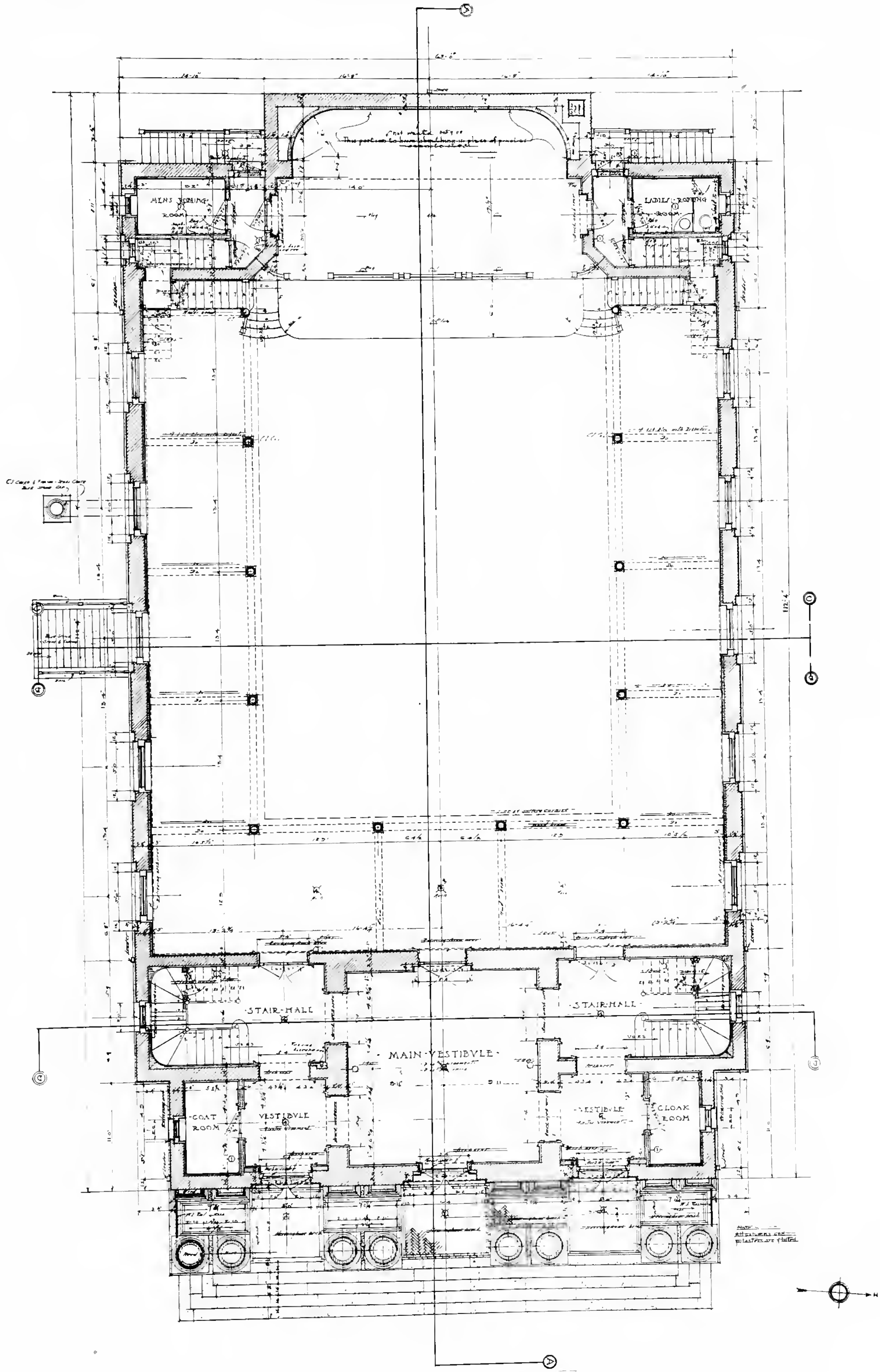
FIRST CONGREGATIONAL CHURCH, DANBURY, CONN.
MESSRS. HOWELLS & STOKES, *ARCHITECTS*



FIRST CONGREGATIONAL CHURCH, DANBURY, CONN.
MESSRS. HOWELLS & STOKES, *ARCHITECTS*

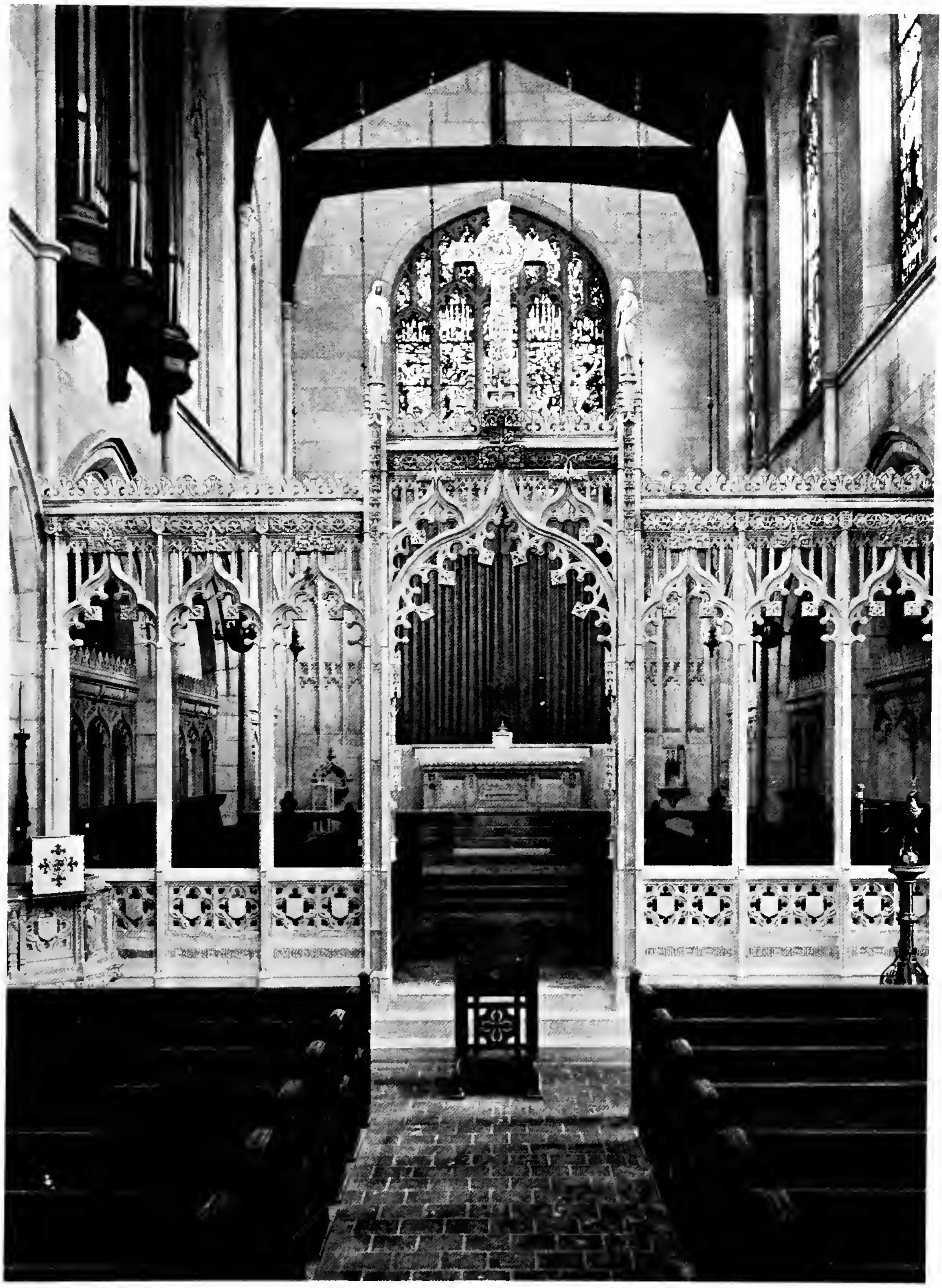


FIRST CONGREGATIONAL CHURCH, DANBURY, CONN.
MESSRS HOWELLS & STOKES, *ARCHITECTS*



FIRST CONGREGATIONAL CHURCH, DANBURY, CONN.
MESSRS. HOWELLS & STOKES, *ARCHITECTS*

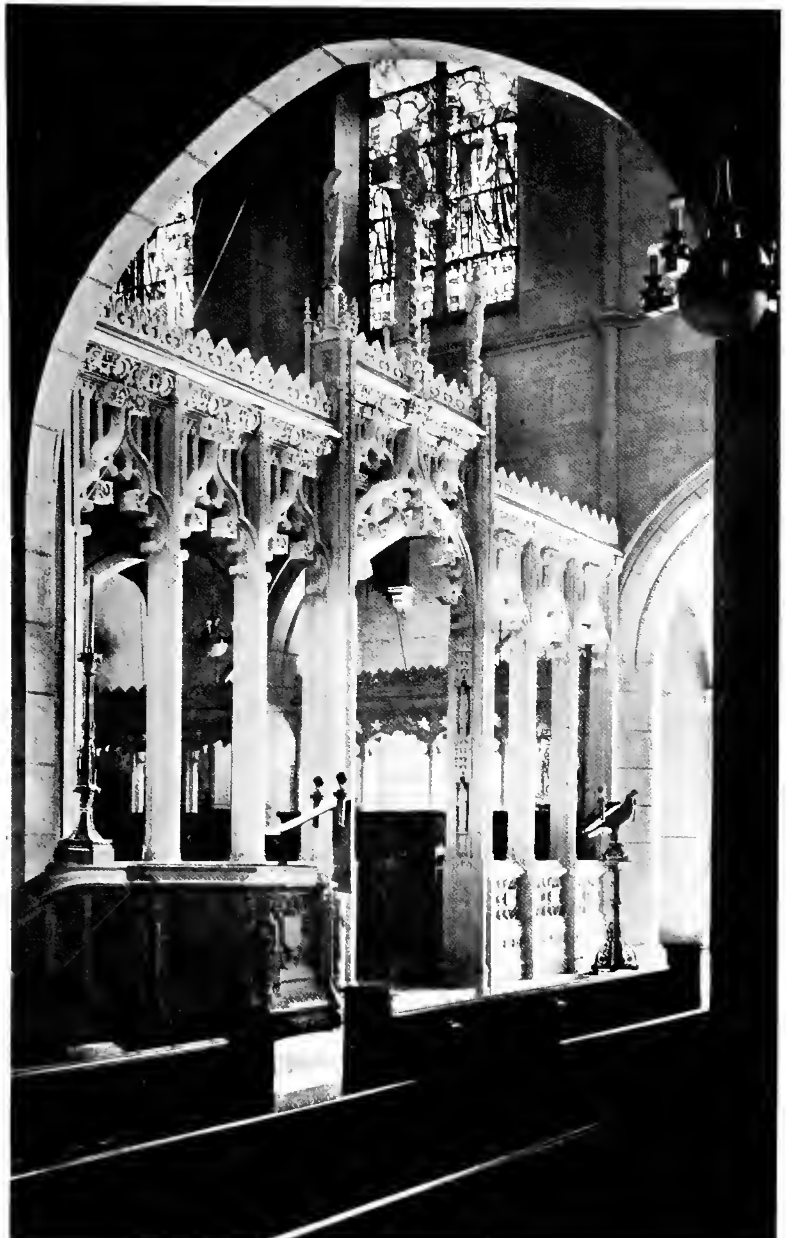
ST. MARK'S CHURCH, FRANKFORD, PHILADELPHIA, PA.
MESSRS. WATSON & HUCKEL, *ARCHITECTS*



ROOD SCREEN

ST. MARK'S CHURCH, FRANKFORD, PHILADELPHIA, PA.

MESSRS. WATSON & HUCKEL, *ARCHITECTS*



ROOD SCREEN

SANCTUARY

ST. MARK'S CHURCH, FRANKFORD, PHILADELPHIA, PA.

MESSRS. WATSON & HUCKEL, *ARCHITECTS*

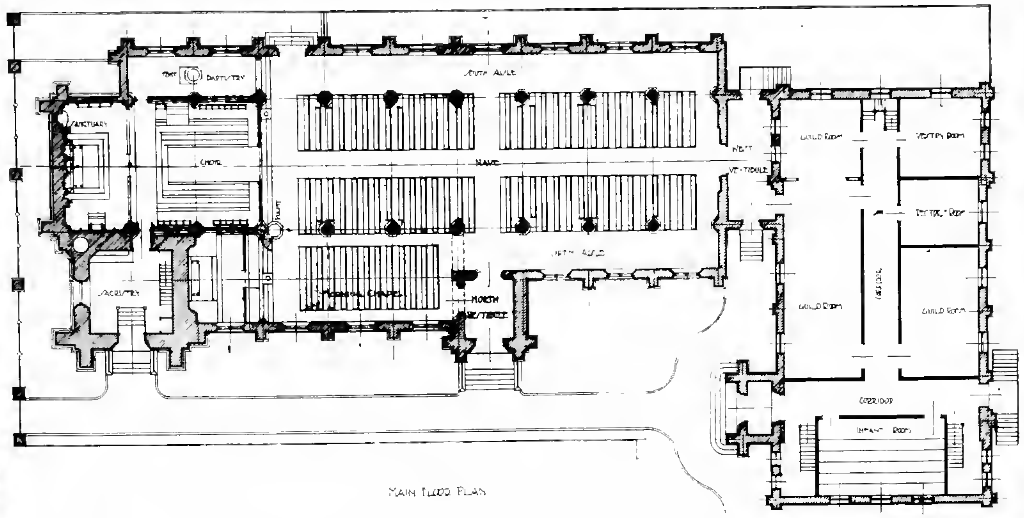
DETAIL OF PULPIT

BISHOP'S THRONE

ST. MARK'S CHURCH, FRANKFORD, PHILADELPHIA, PA.

MESSRS. WATSON & HUCKEL, *ARCHITECTS*

LITANY DESK

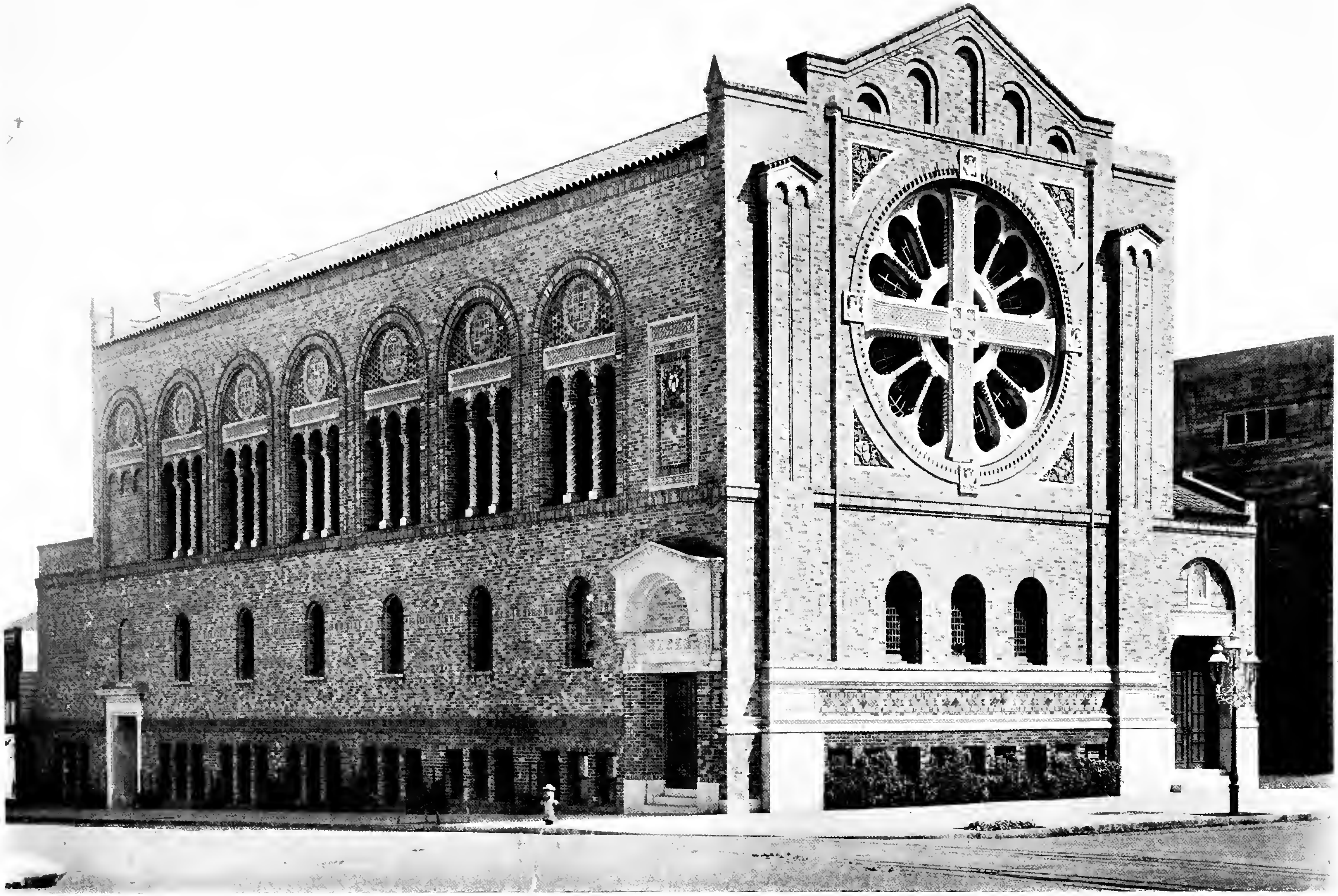


PLAN

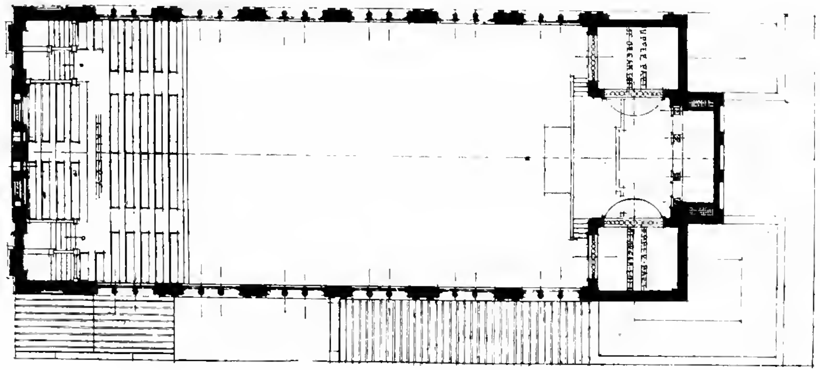
LECTERN

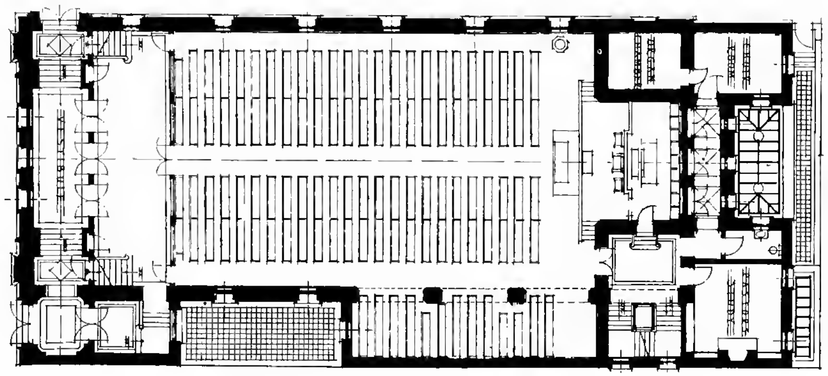
ST. MARK'S CHURCH, FRANKFORD, PHILADELPHIA, PA.

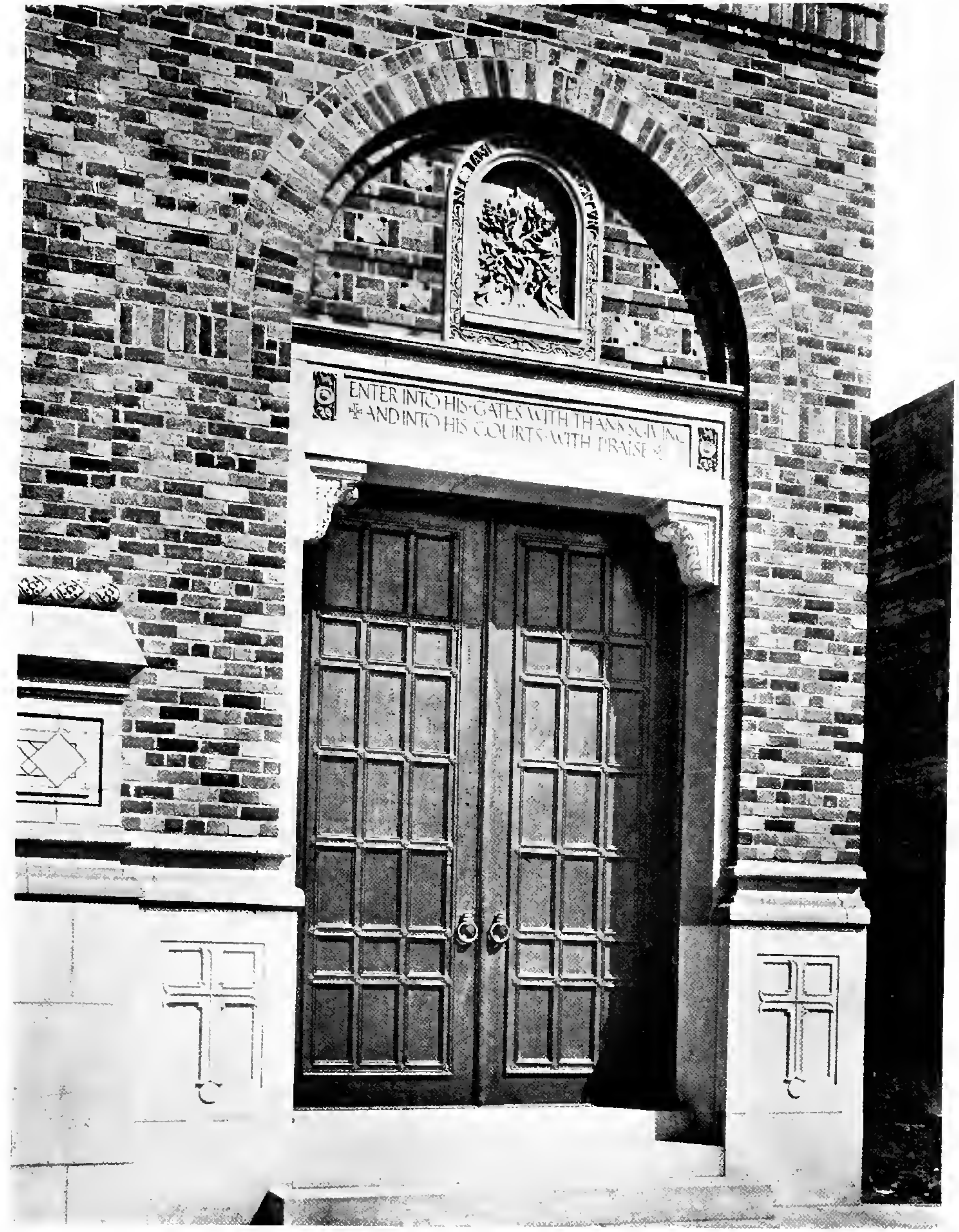
MESSRS. WATSON & HUCKEL, *ARCHITECTS*



FIRST PRESBYTERIAN CHURCH, SAN FRANCISCO, CAL.
MR. WILLIAM C. HAYS, *ARCHITECT*.



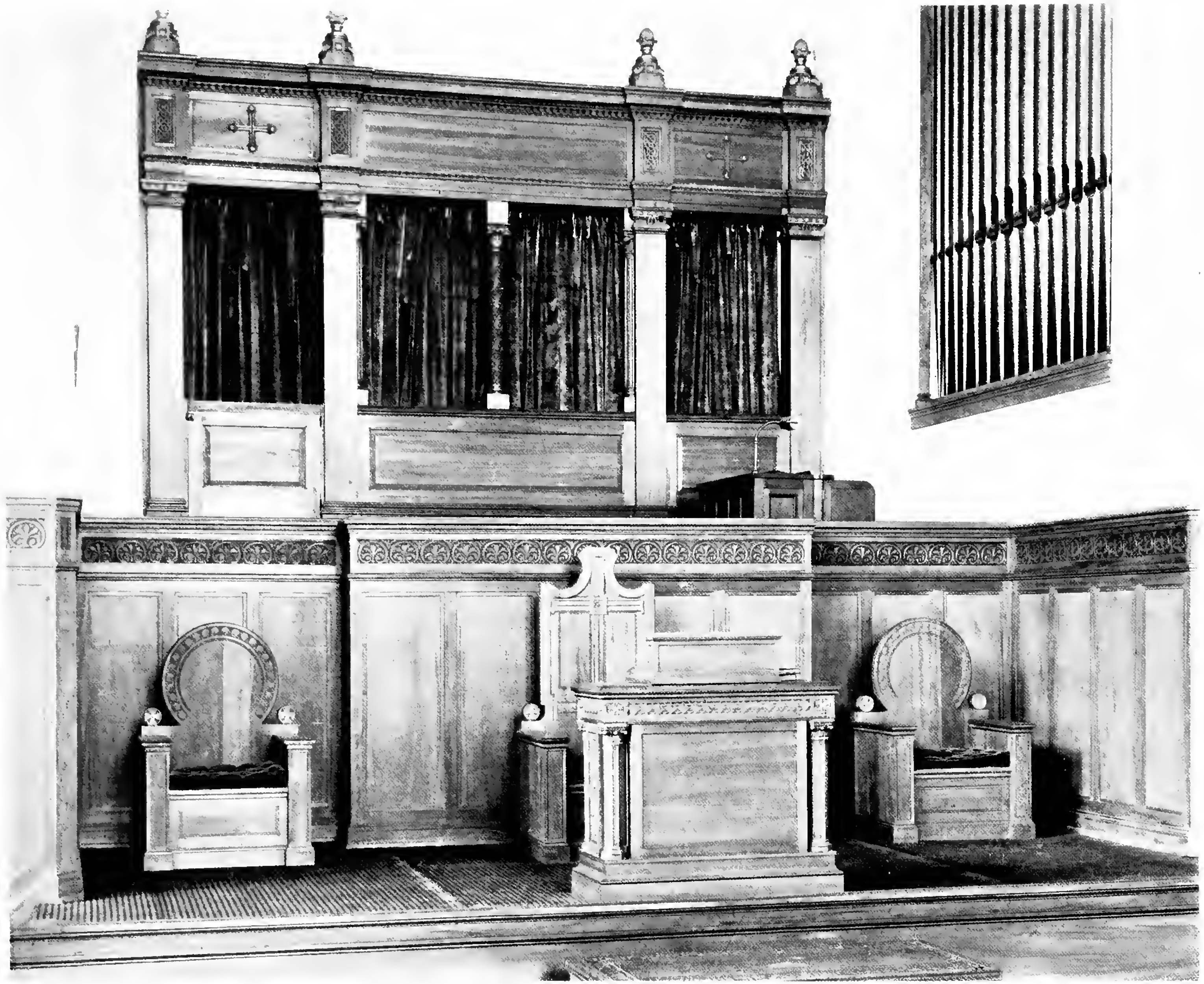




FIRST PRESBYTERIAN CHURCH, SAN FRANCISCO, CAL.

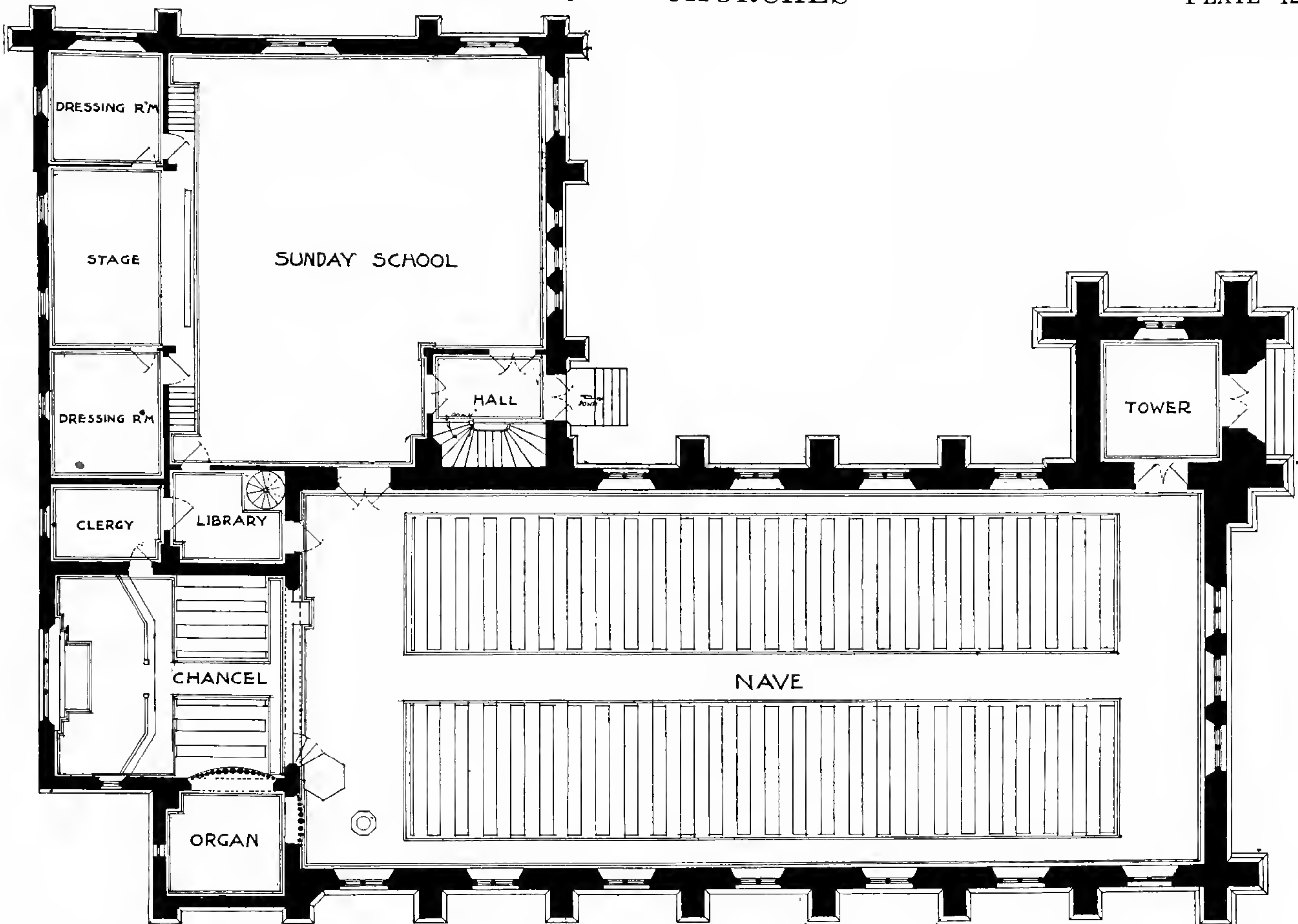
MR. WILLIAM C. HAYS, *ARCHITECT.*

FIRST PRESBYTERIAN CHURCH, SAN FRANCISCO, CAL.
MR. WILLIAM C. HAYS, *ARCHITECT*.

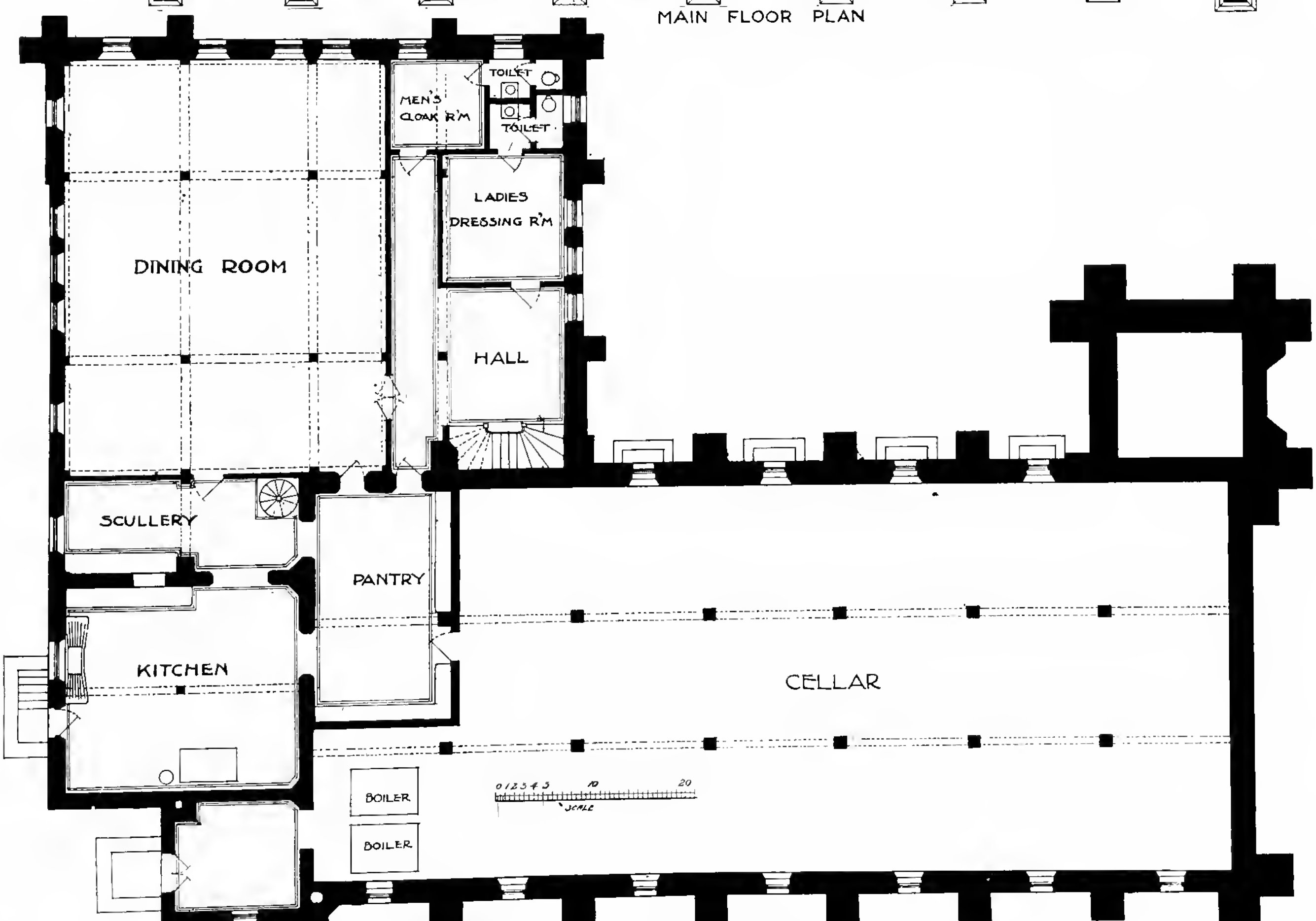


FIRST PRESBYTERIAN CHURCH, SAN FRANCISCO, CAL.
MR. WILLIAM C. HAYS, *ARCHITECT*

UNIVERSALIST CHURCH, WATERTOWN, N. Y.
MR. HORACE F. UPJOHN, *ARCHITECT*



MAIN FLOOR PLAN

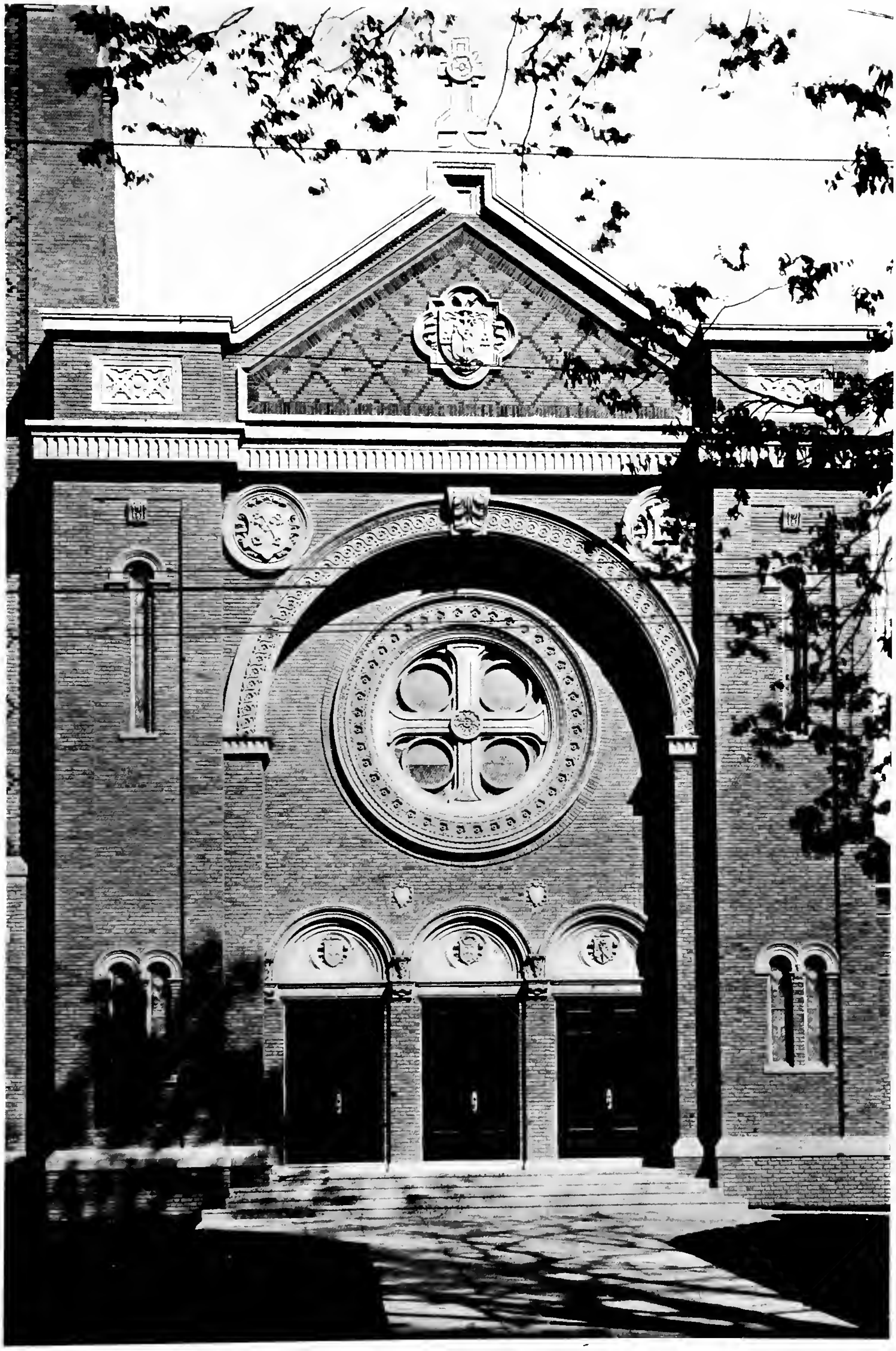


BASEMENT PLAN

UNIVERSALIST CHURCH, WATERTOWN, N. Y.

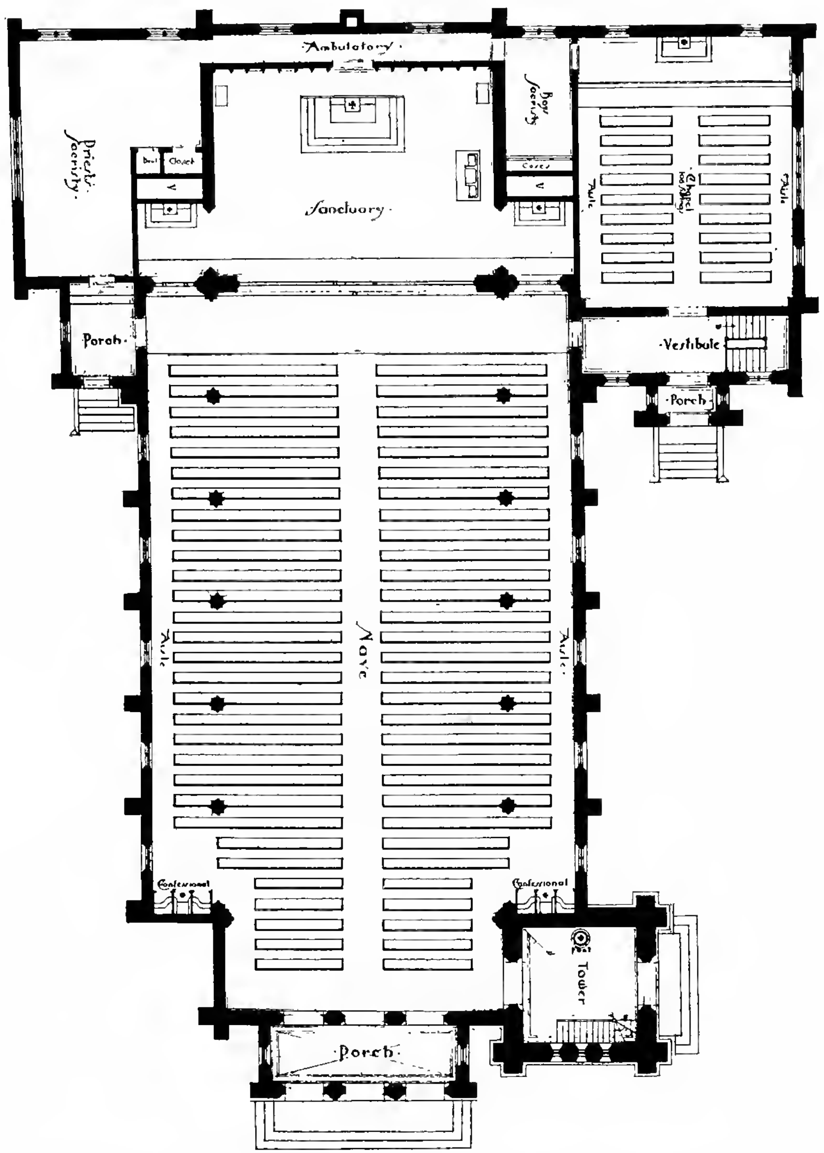
MR. HORACE F. UPJOHN, *ARCHITECT*

CHURCH OF THE IMMACULATE CONCEPTION, WEST SPRINGFIELD, MASS.
MR. JOHN WILLIAM DONOHOE, *ARCHITECT*

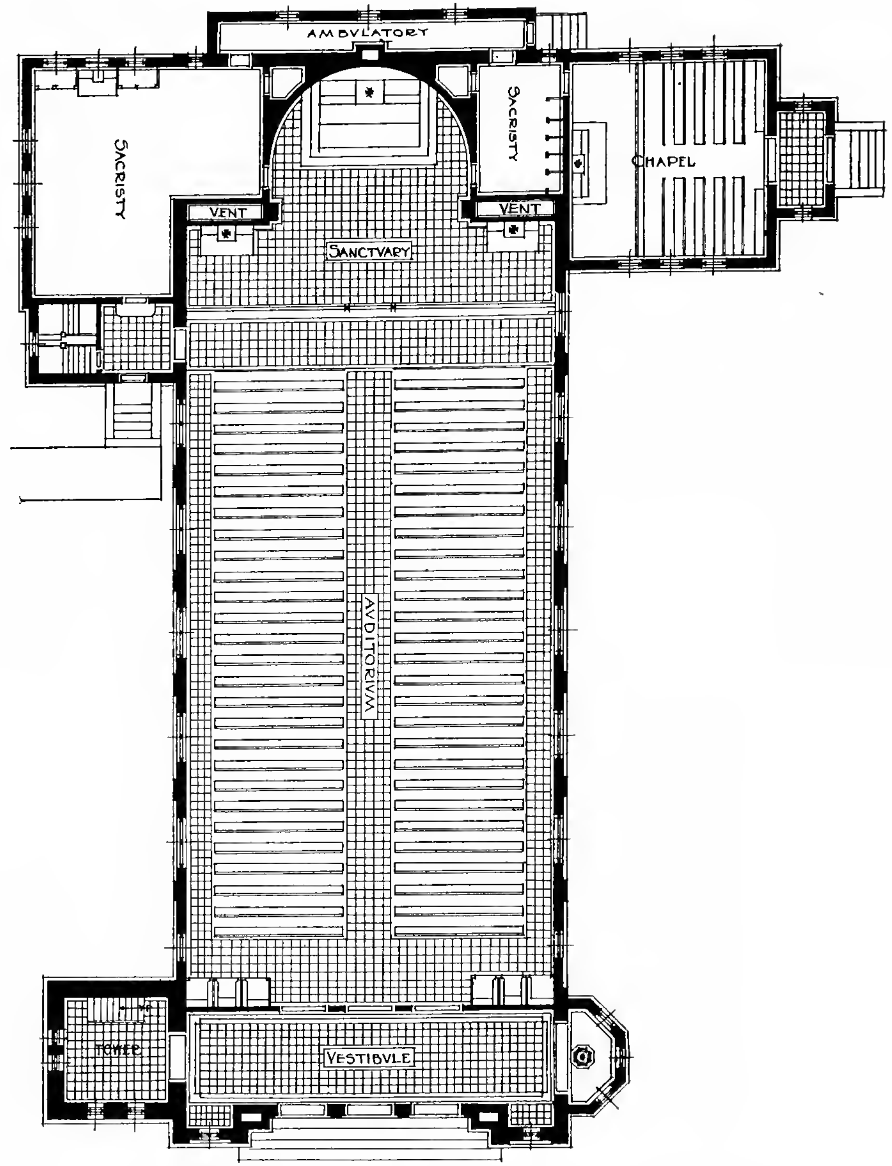


CHURCH OF THE IMMACULATE CONCEPTION, WEST SPRINGFIELD, MASS.
MR. JOHN WILLIAM DONOHOE, *ARCHITECT*

CHURCH OF THE IMMACULATE HEART OF MARY, WINCHENDON, MASS.
MR. JOHN WILLIAM DONOHOE, *ARCHITECT*



CHURCH OF IMMACULATE HEART OF MARY,
WINCHENDON, MASS.

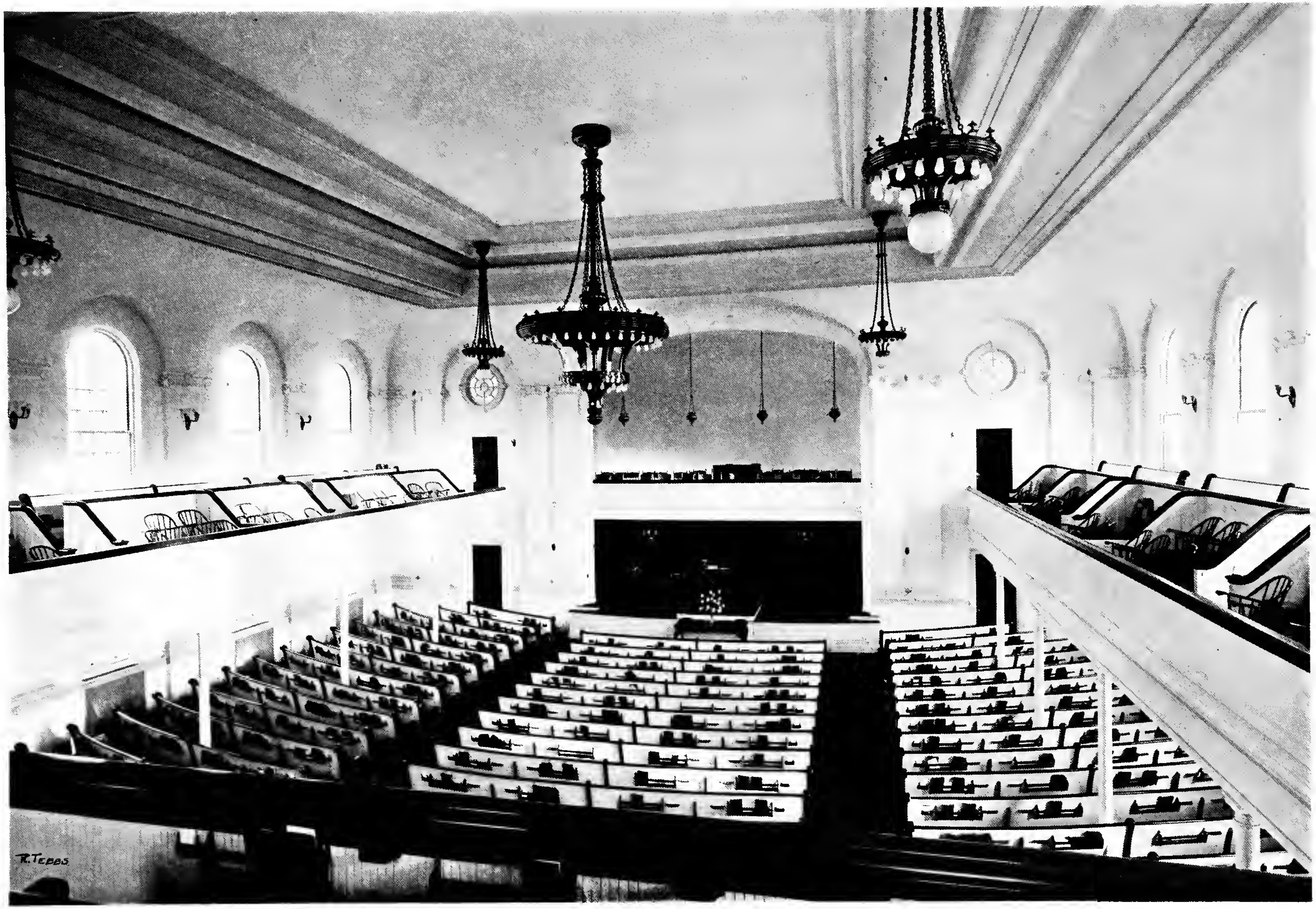


CHURCH OF THE IMMACULATE CONCEPTION,
WEST SPRINGFIELD, MASS.

MR. JOHN WILLIAM DONOHOE, *ARCHITECT*

CONGREGATIONAL CHURCH, FLATBUSH, NEW YORK

MESSRS. ALLEN & COLLENS, *ARCHITECTS;* MR. LOUIS E. JALLADE, *ASSOCIATE*



CONGREGATIONAL CHURCH, FLATBUSH, NEW YORK

MESSRS. ALLEN & COLLENS, *ARCHITECTS:* MR. LOUIS E. JALLADE, *ASSOCIATE*

FIRST CHURCH OF CHRIST SCIENTIST, LOS ANGELES, CAL.

MR. ELMER GREY, *ARCHITECT*

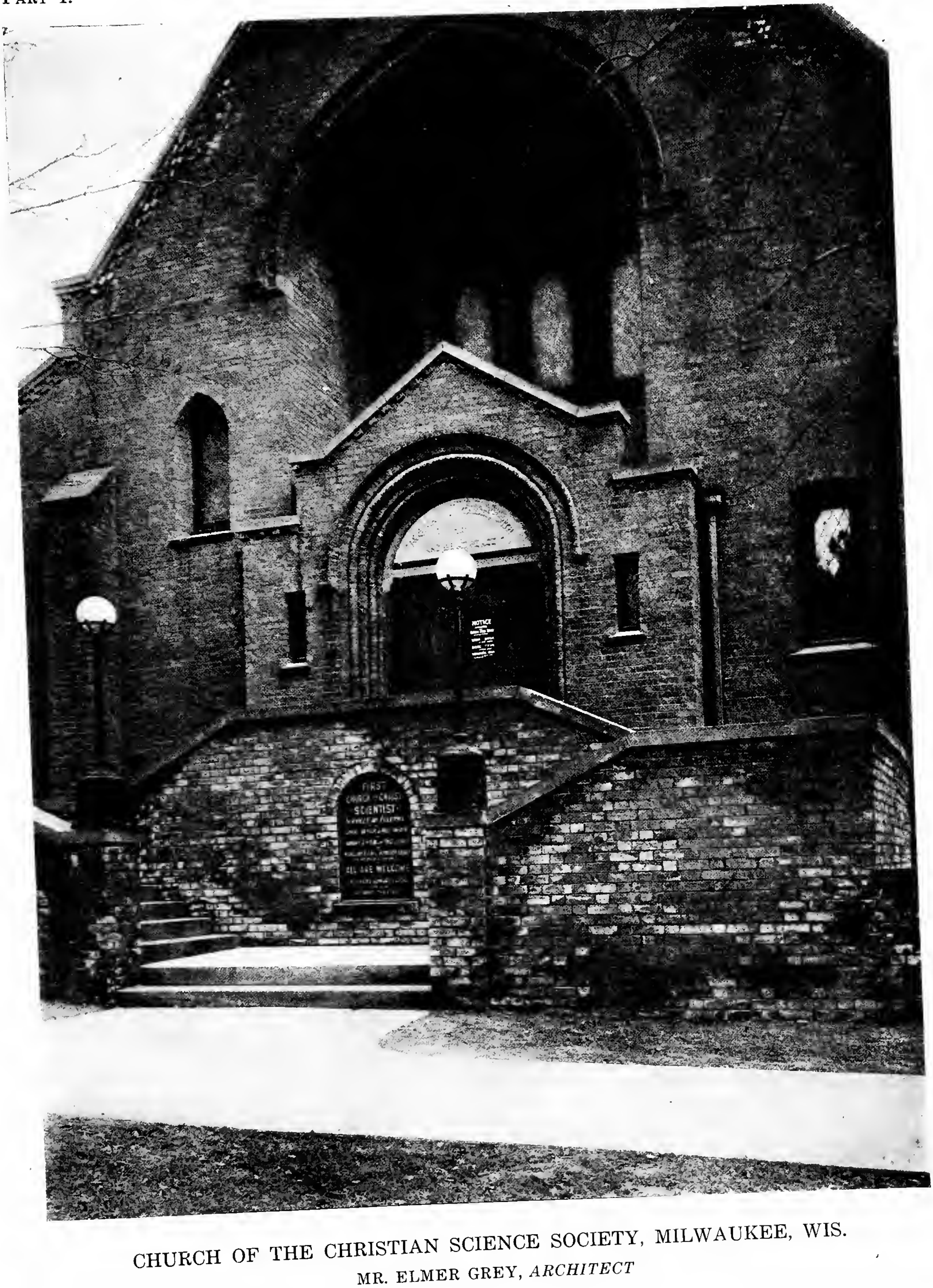
ENTRANCE PORCH

FIRST CHURCH OF CHRIST SCIENTIST, LOS ANGELES, CAL.

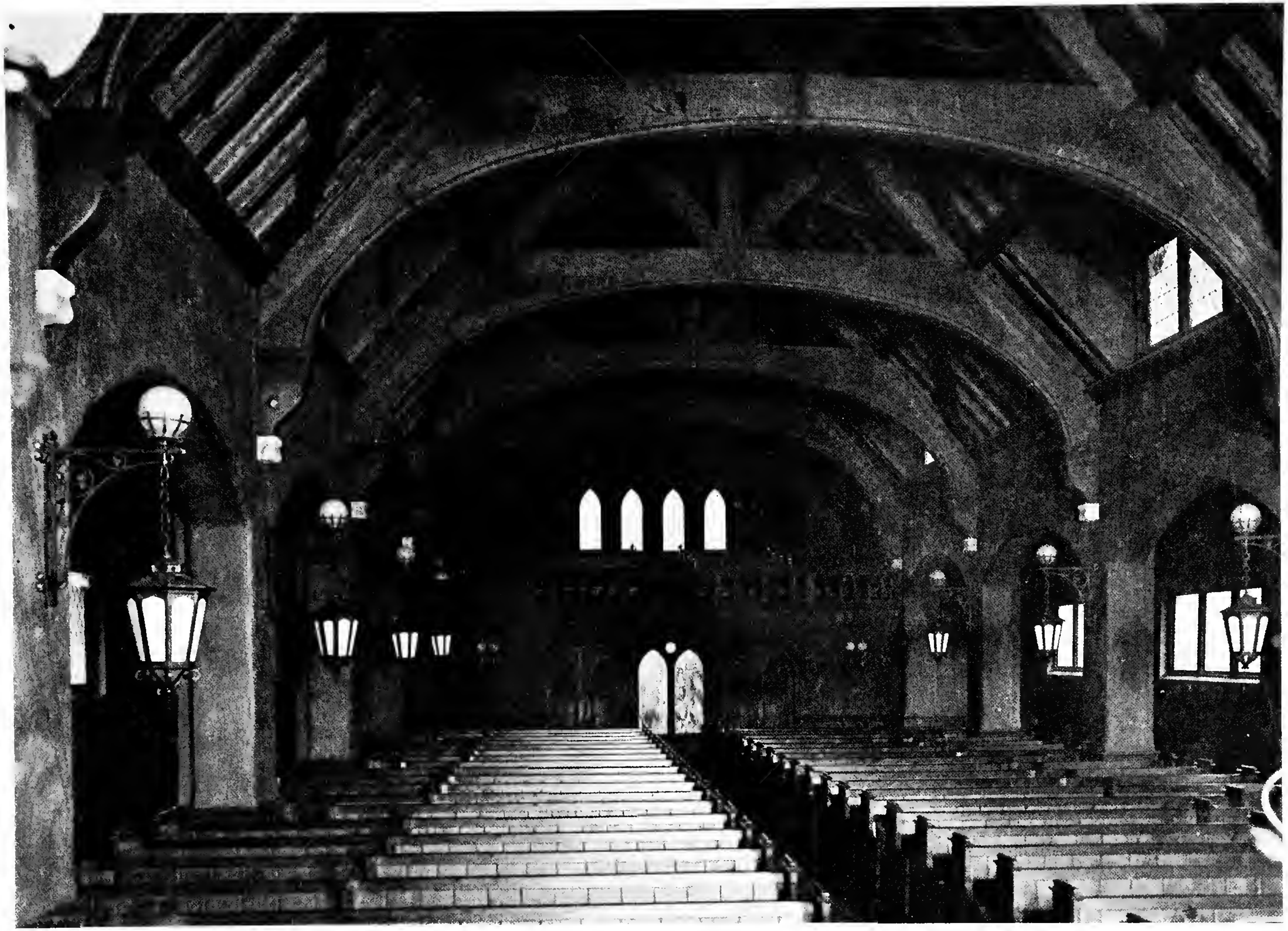
MR. ELMER GREY, *ARCHITECT*

DETAIL OF LOGGIA

FIRST CHURCH OF CHRIST SCIENTIST, LOS ANGELES, CAL.
MR. ELMER GREY, *ARCHITECT*



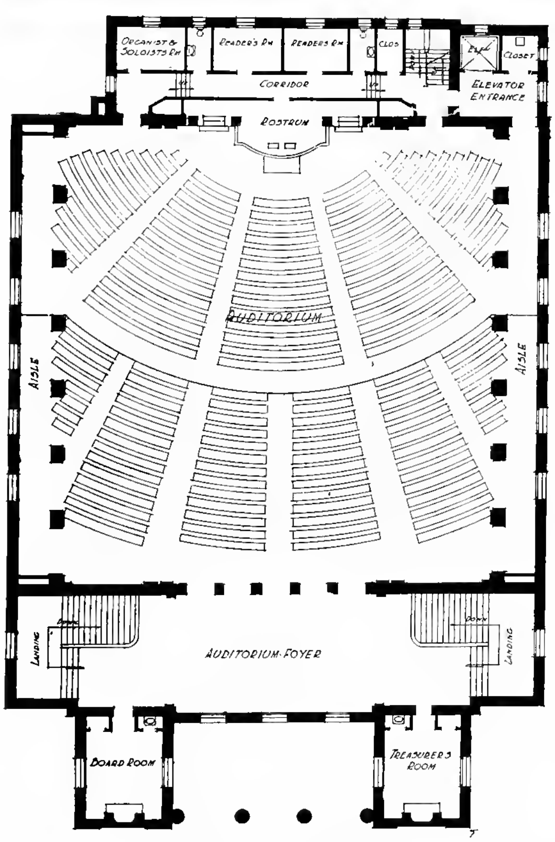
CHURCH OF THE CHRISTIAN SCIENCE SOCIETY, MILWAUKEE, WIS.
MR. ELMER GREY, *ARCHITECT*



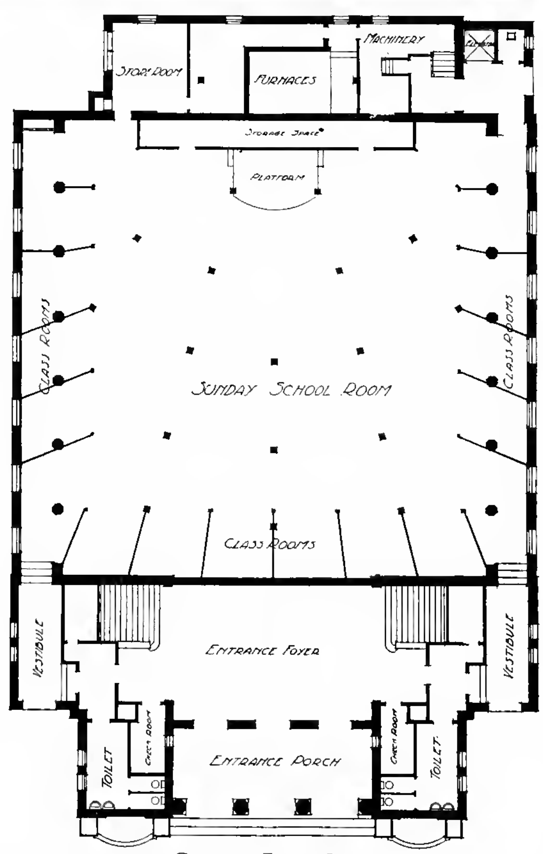
CHURCH OF THE CHRISTIAN SCIENCE SOCIETY, MILWAUKEE, WIS.

MR. ELMER GREY, *ARCHITECT*

FIRST CHURCH OF CHRIST SCIENTIST, LONG BEACH, CAL.
MR. ELMER GREY, *ARCHITECT*



AUDITORIUM FLOOR PLAN



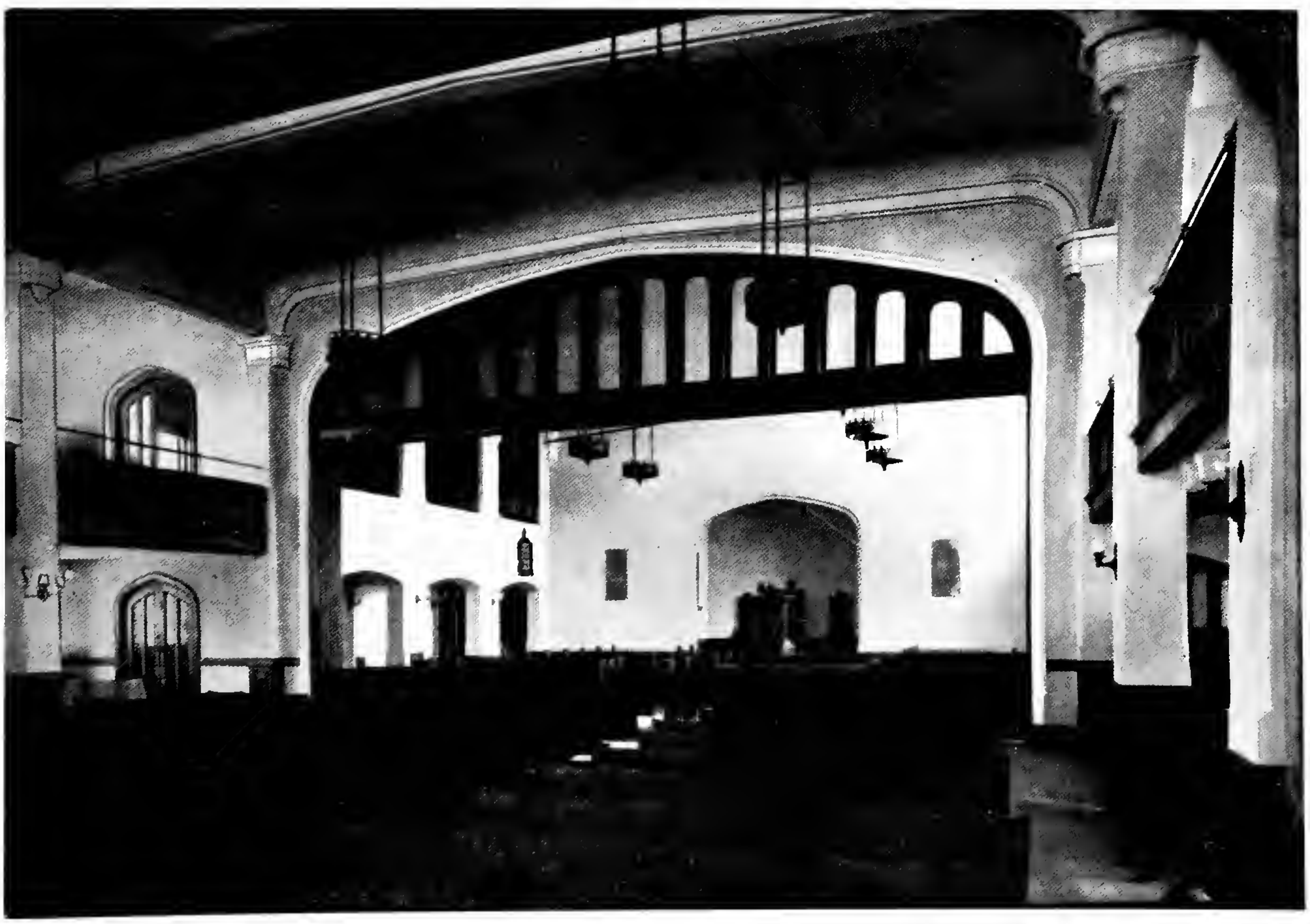
GROUND FLOOR PLAN

FIRST CHURCH OF CHRIST SCIENTIST, LONG BEACH, CAL.

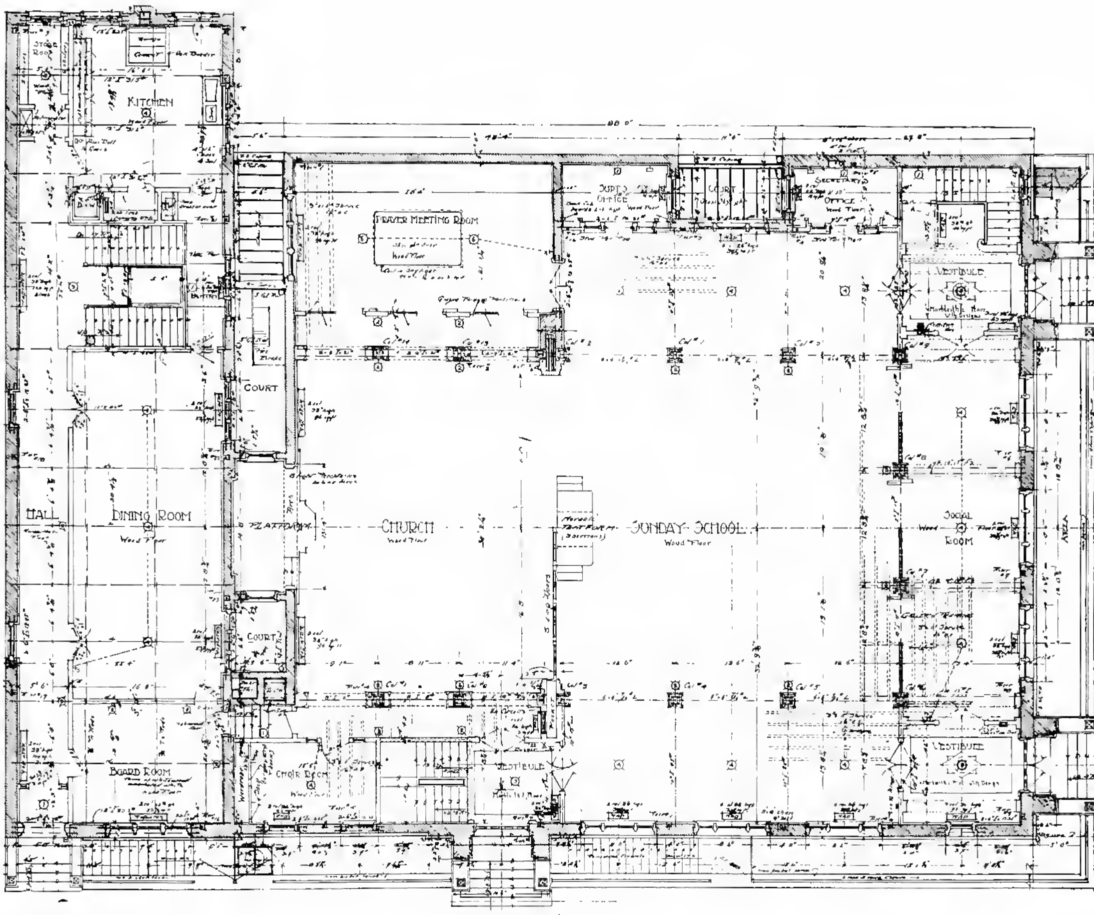
MR. ELMER GREY, *ARCHITECT*

BETHANY MEMORIAL CHURCH, SIXTY-SEVENTH STREET AND FIRST AVENUE, NEW YORK
MESSRS. NELSON & VAN WAGENEN, *ARCHITECTS*

BETHANY MEMORIAL CHURCH, SIXTY-SEVENTH STREET AND FIRST AVENUE, NEW YORK
MESSRS. NELSON & VAN WAGENEN, *ARCHITECTS*



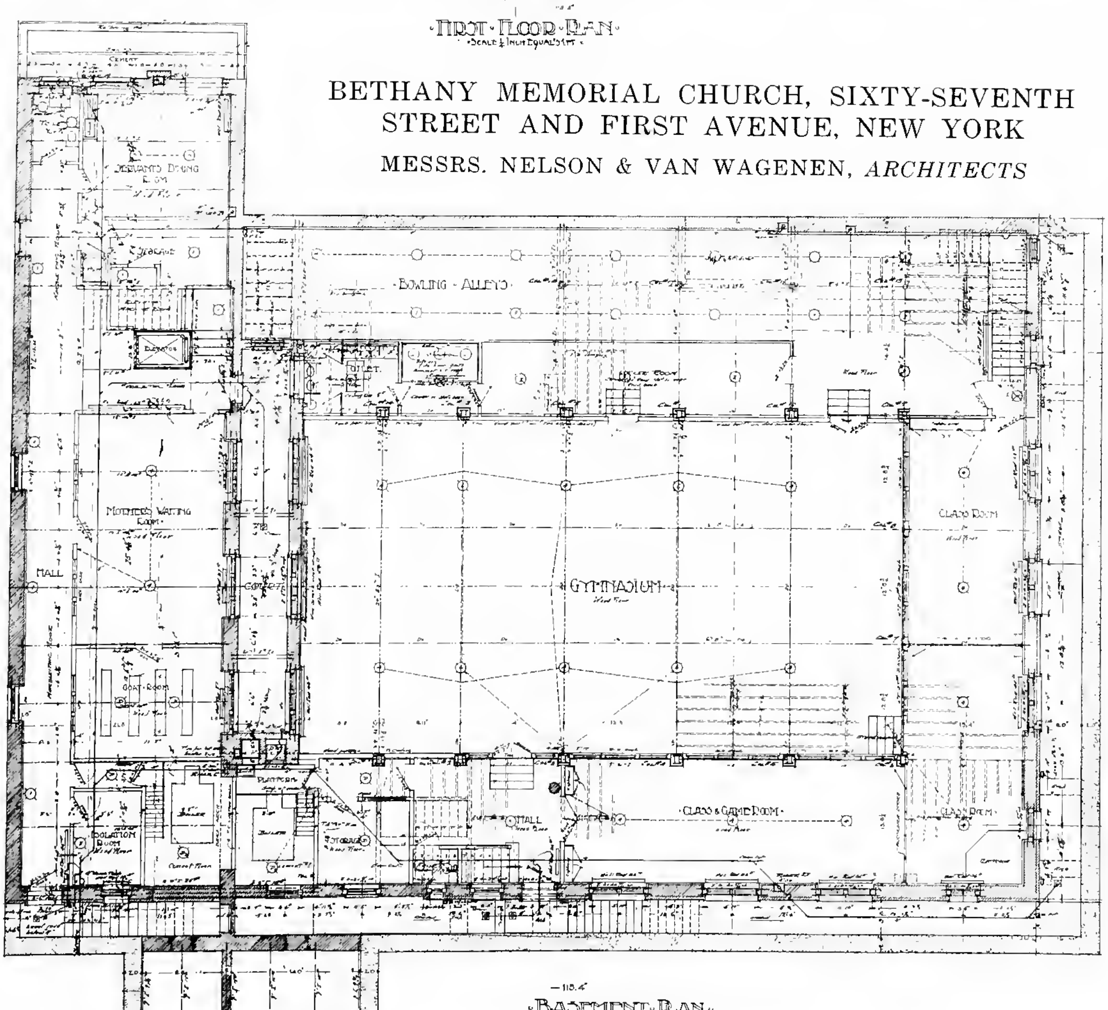
BETHANY MEMORIAL CHURCH, SIXTY-SEVENTH ST. AND FIRST AVE., NEW YORK
MESSRS. NELSON & VAN WAGENEN, *ARCHITECTS*



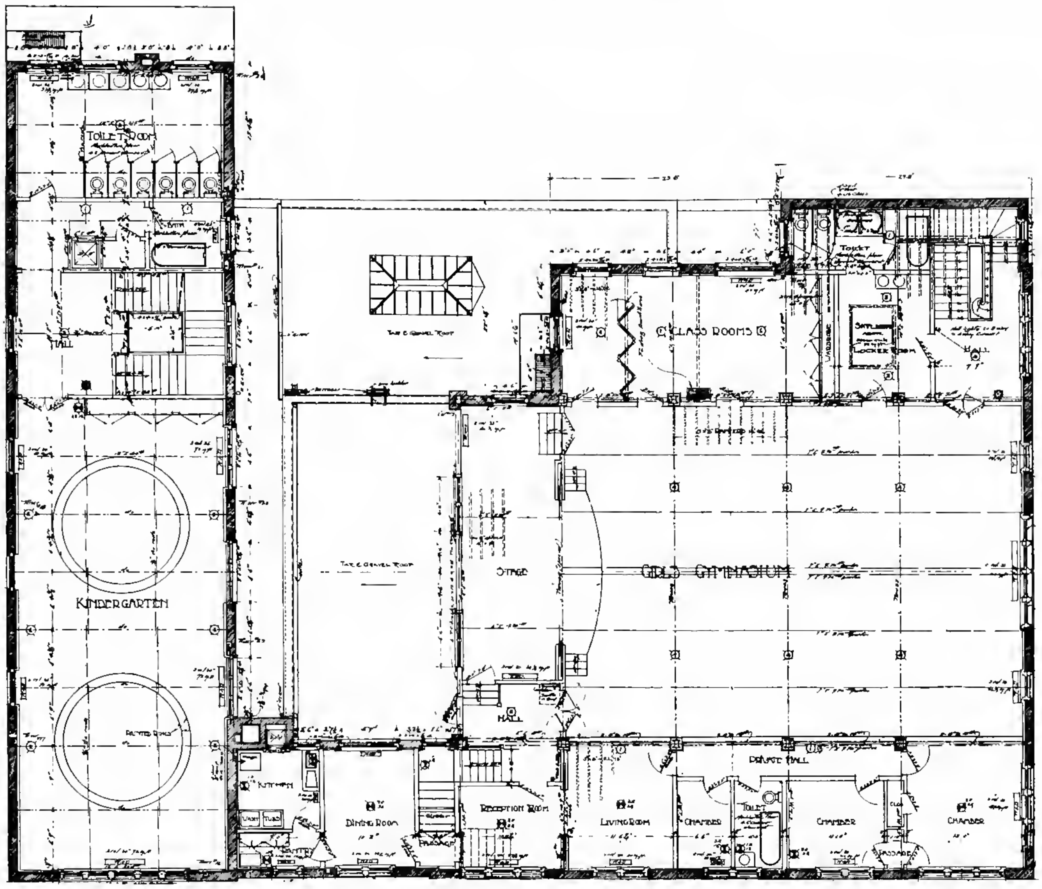
FIRST FLOOR PLAN
SCALE ⅛ INCH EQUALS 1 FT

BETHANY MEMORIAL CHURCH, SIXTY-SEVENTH STREET AND FIRST AVENUE, NEW YORK

MESSRS. NELSON & VAN WAGENEN, *ARCHITECTS*



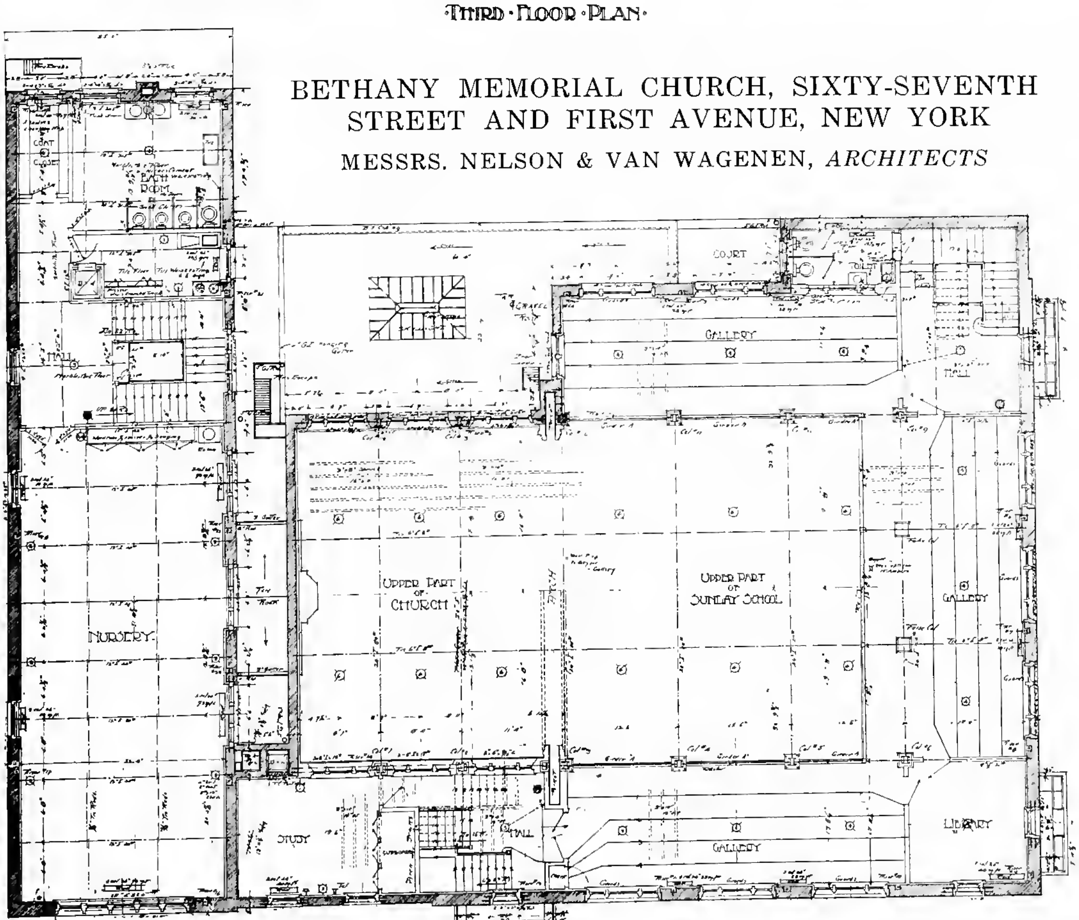
BASEMENT PLAN
SCALE ⅛" EQUALS 1 FOOT



·THIRD·FLOOR·PLAN·

BETHANY MEMORIAL CHURCH, SIXTY-SEVENTH STREET AND FIRST AVENUE, NEW YORK

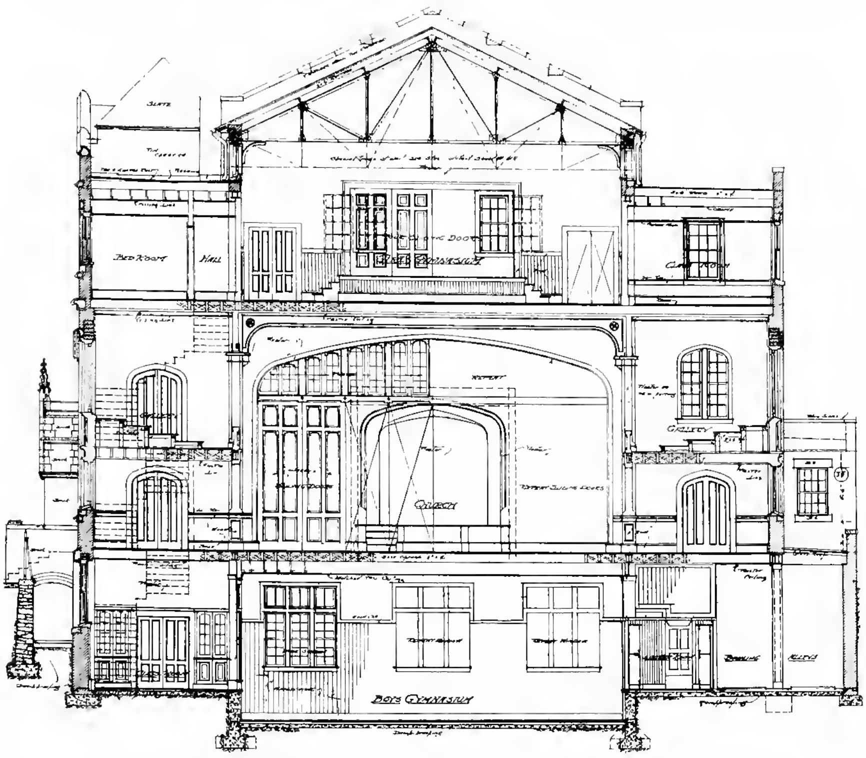
MESSRS. NELSON & VAN WAGENEN, *ARCHITECTS*



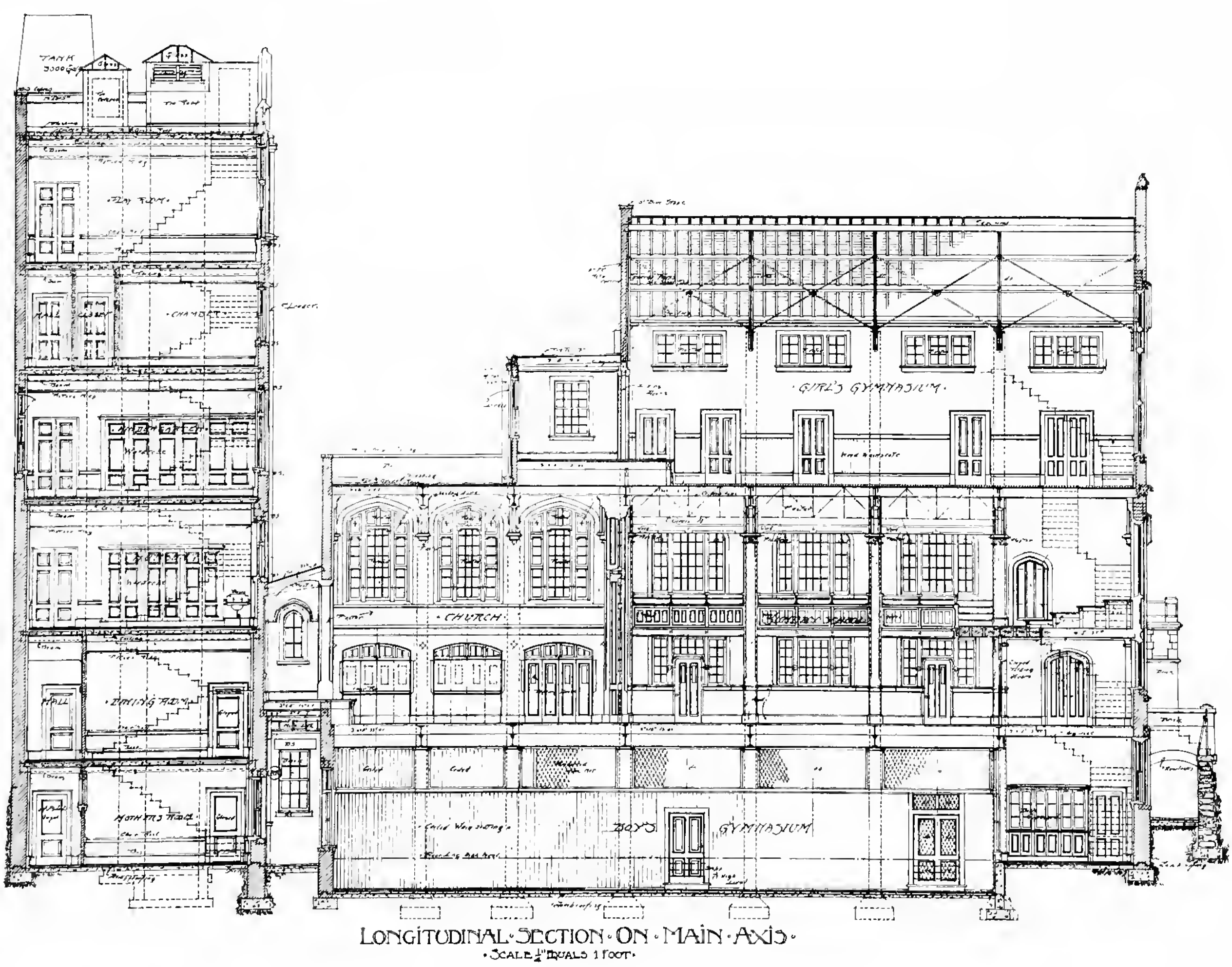
·SECOND·FLOOR·PLAN·
·SCALE 1/8 INCH EQUALS 1 FOOT·

BETHANY MEMORIAL CHURCH
SIXTY-SEVENTH STREET
AND FIRST AVENUE
NEW YORK

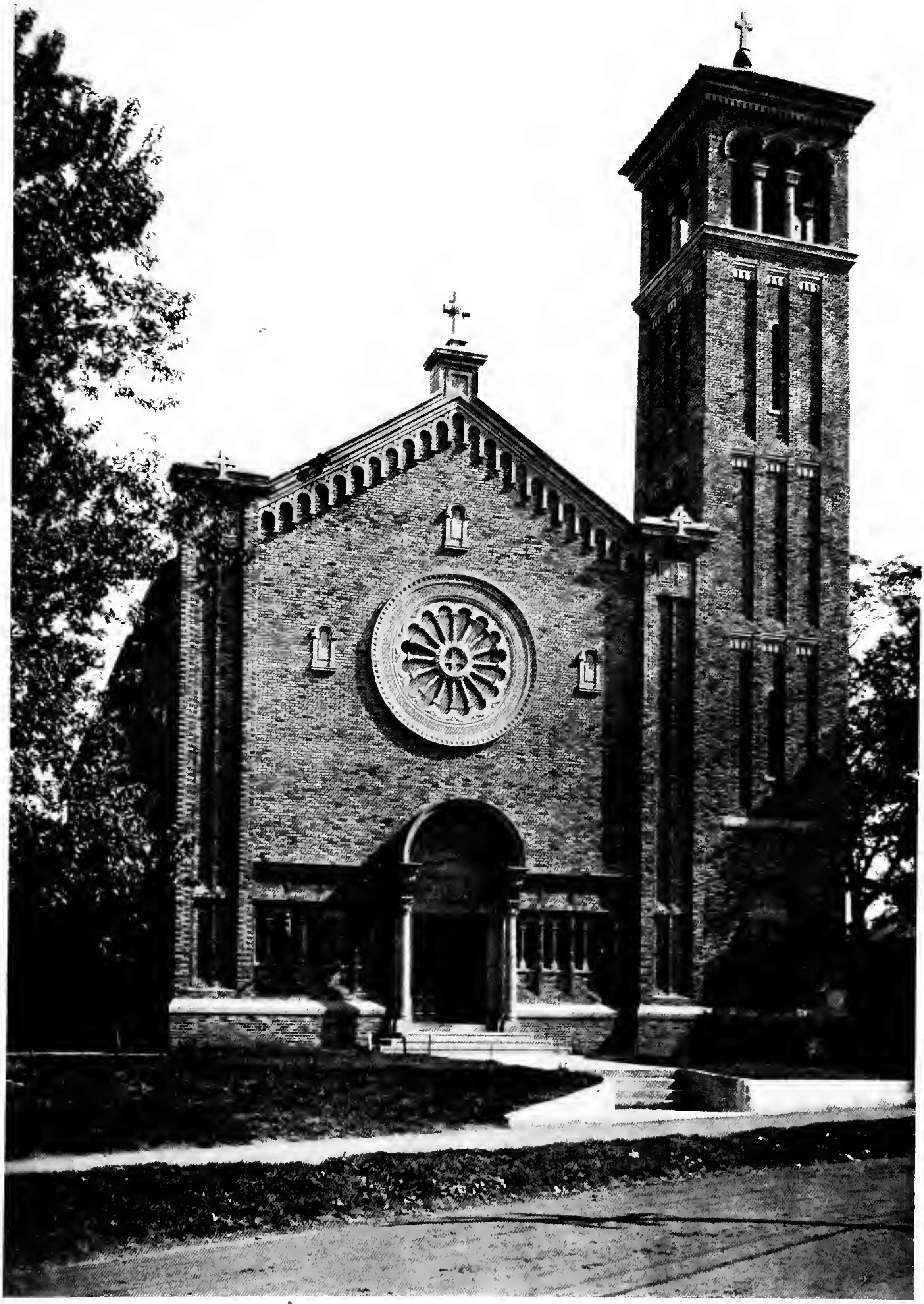
MESSRS. NELSON & VAN WAGENEN, *ARCHITECTS*



·TRANSVERSE·SECTION·THROUGH·CHURCH·HOUSE·
·LOOKING·EAST·

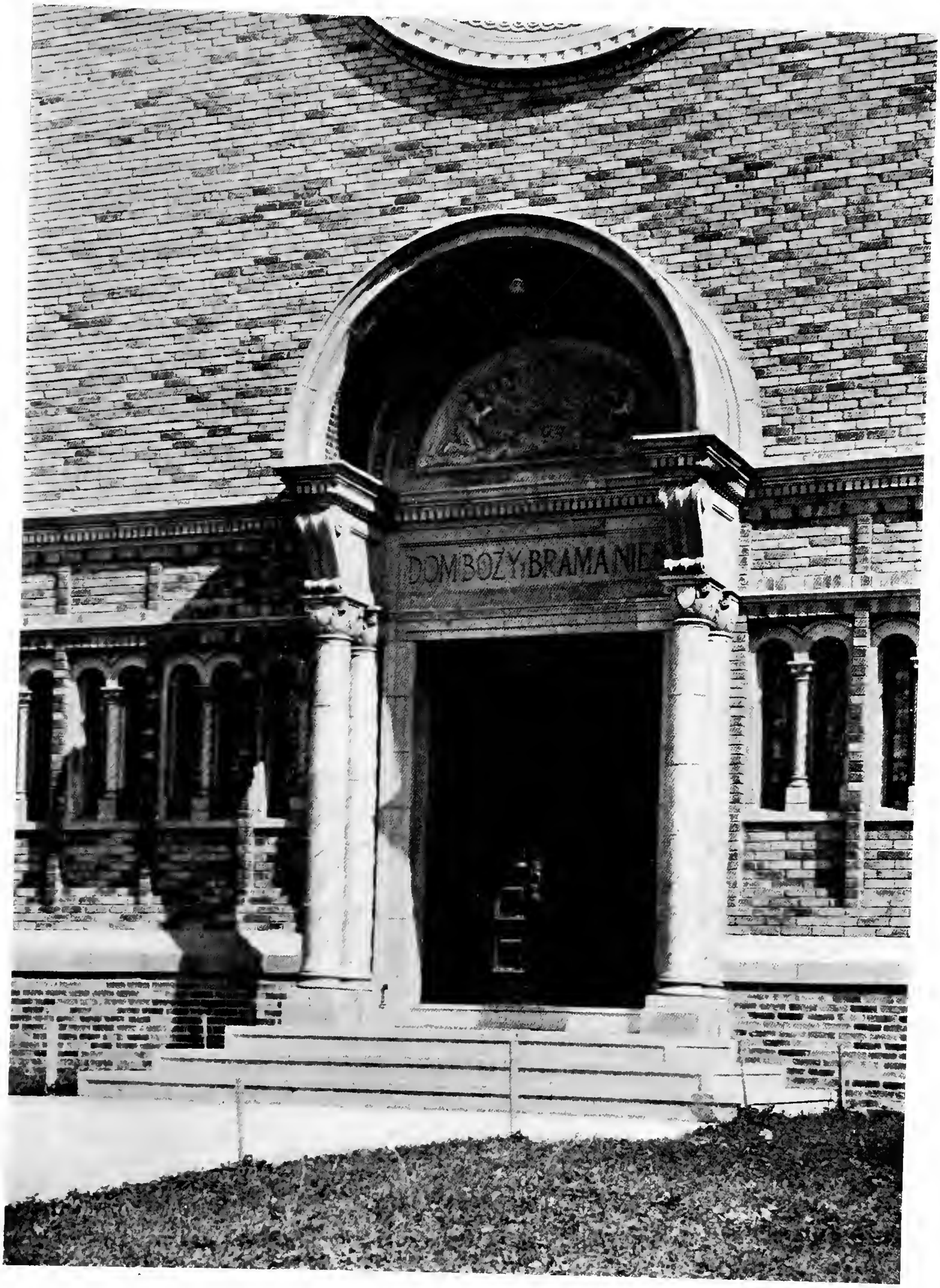


LONGITUDINAL·SECTION·ON·MAIN·AXIS·
·SCALE ⅛" EQUALS 1 FOOT·



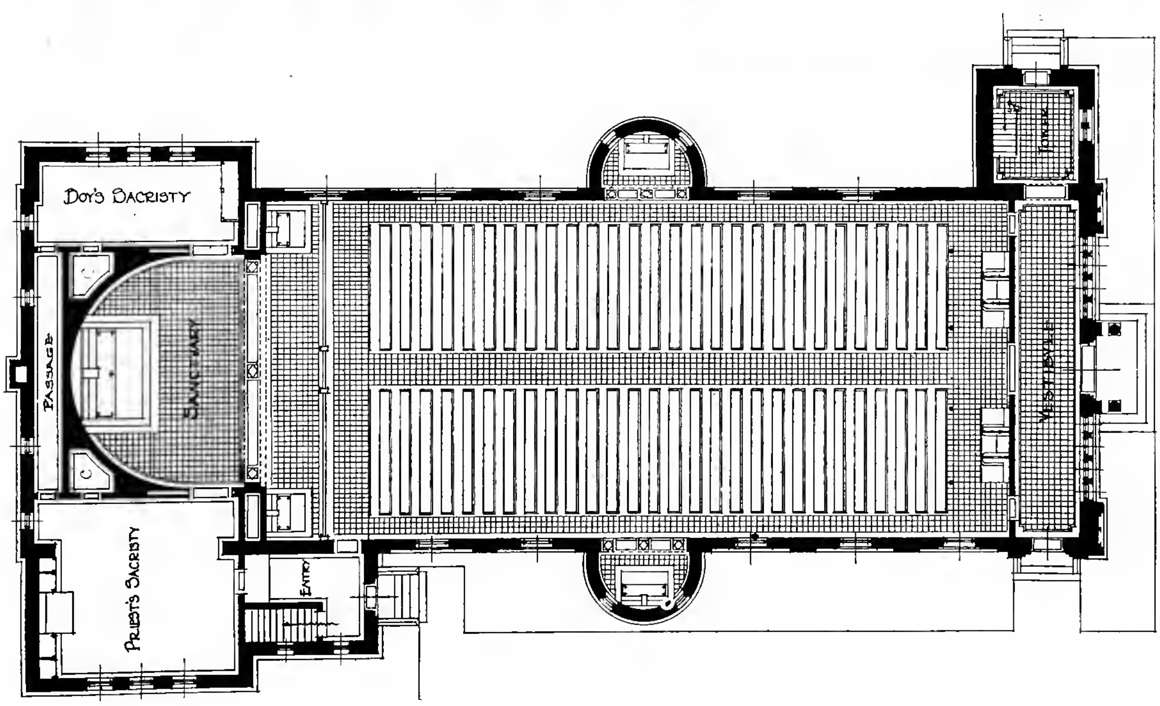
CHURCH OF ST. JOHN CANTIUS, NORTHAMPTON, MASS.

MR. JOHN WILLIAM DONOHOE, *ARCHITECT*



CHURCH OF ST. JOHN CANTIUS, NORTHAMPTON, MASS.
MR. JOHN WILLIAM DONOHOE, *ARCHITECT*

INTERIOR, LOOKING TOWARDS ALTAR

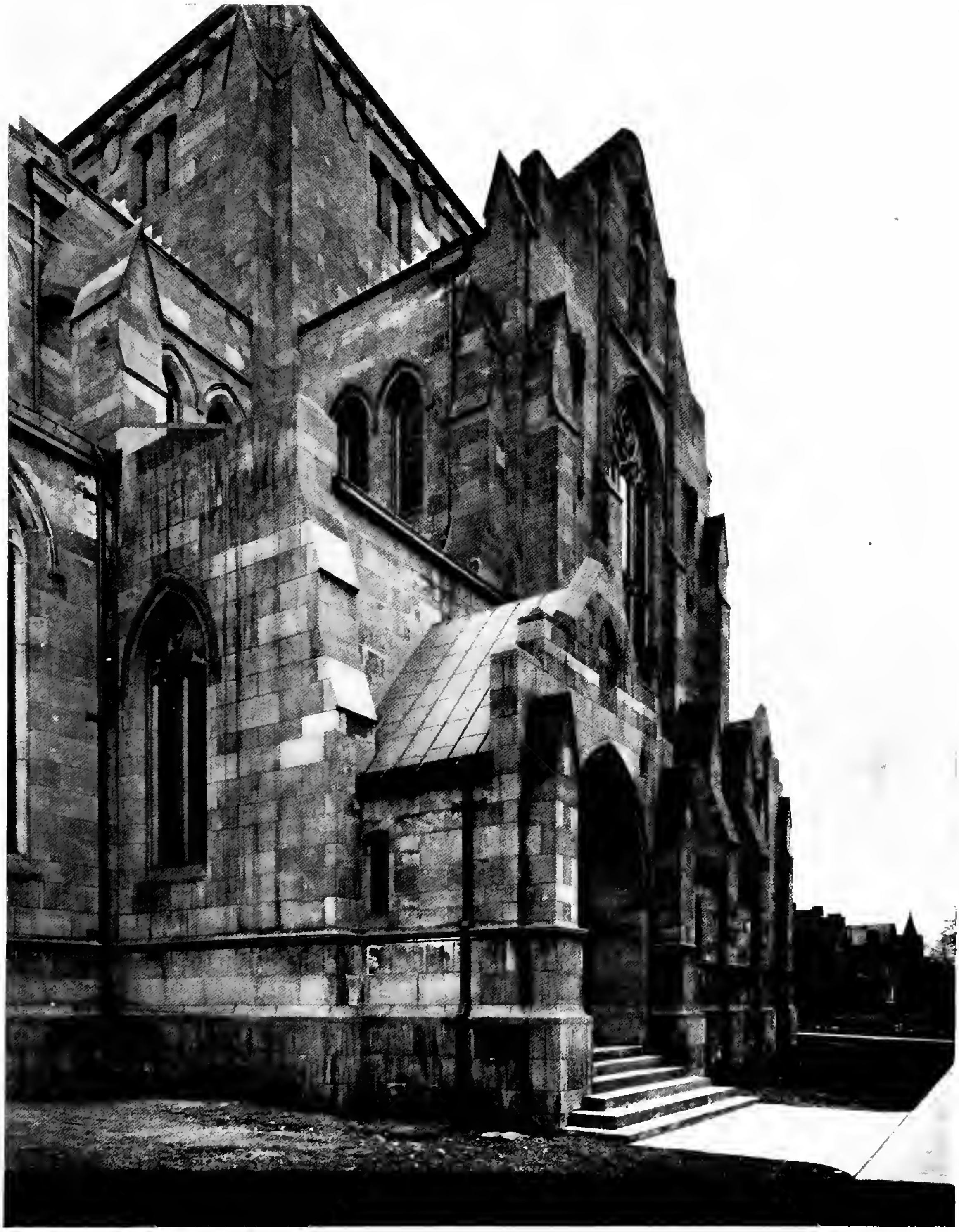


CHURCH OF ST. JOHN CANTIUS, NORTHAMPTON, MASS.

MR. JOHN WILLIAM DONOHOE, *ARCHITECT*

ST. PAUL'S CATHEDRAL, DETROIT, MICH.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



ENTRANCE TO SOUTH TRANSEPT

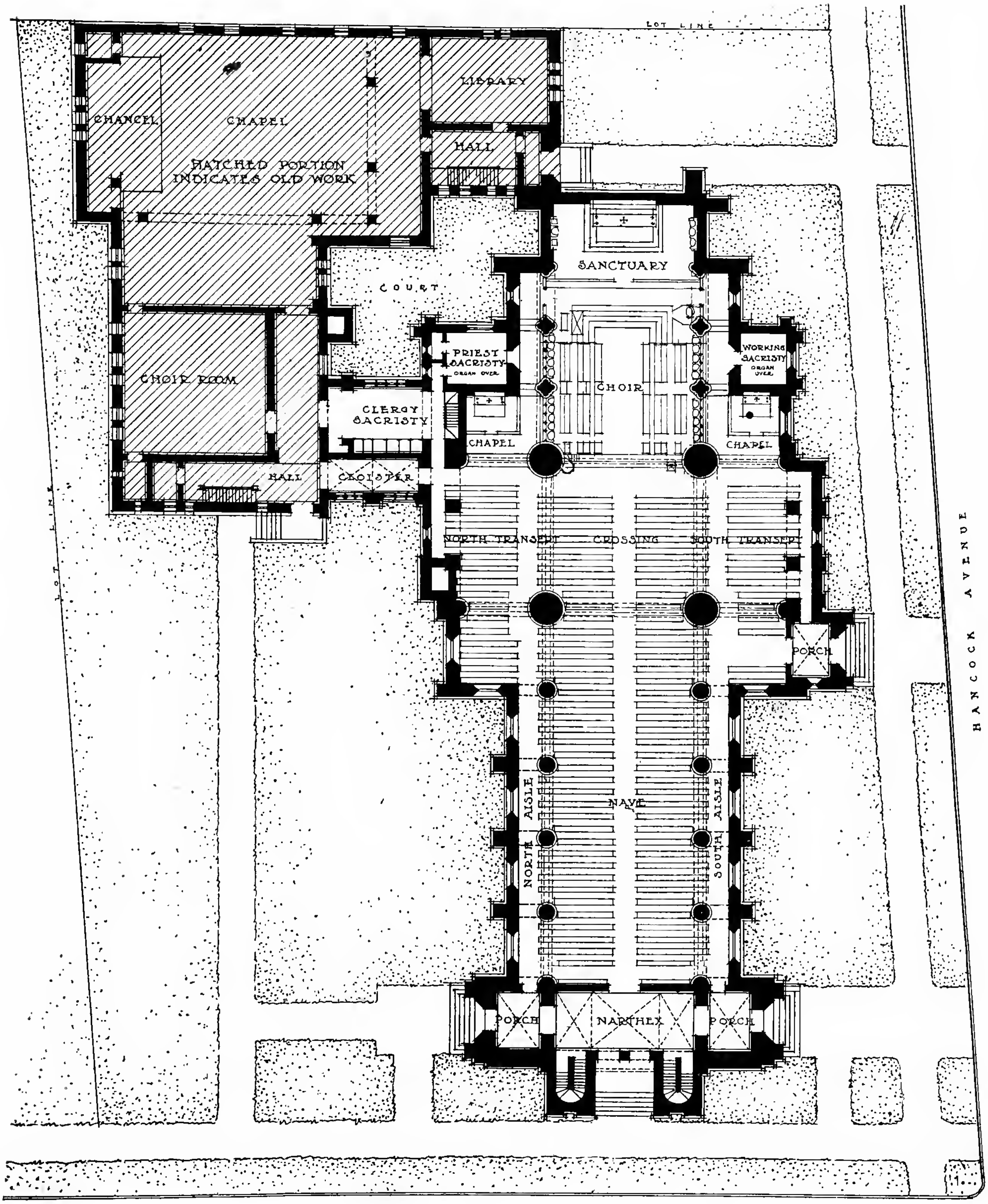
ST. PAUL'S CATHEDRAL, DETROIT, MICH.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

WESTERN ENTRANCE

ST. PAUL'S CATHEDRAL, DETROIT, MICH.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



ST. PAUL'S CATHEDRAL, DETROIT, MICH.

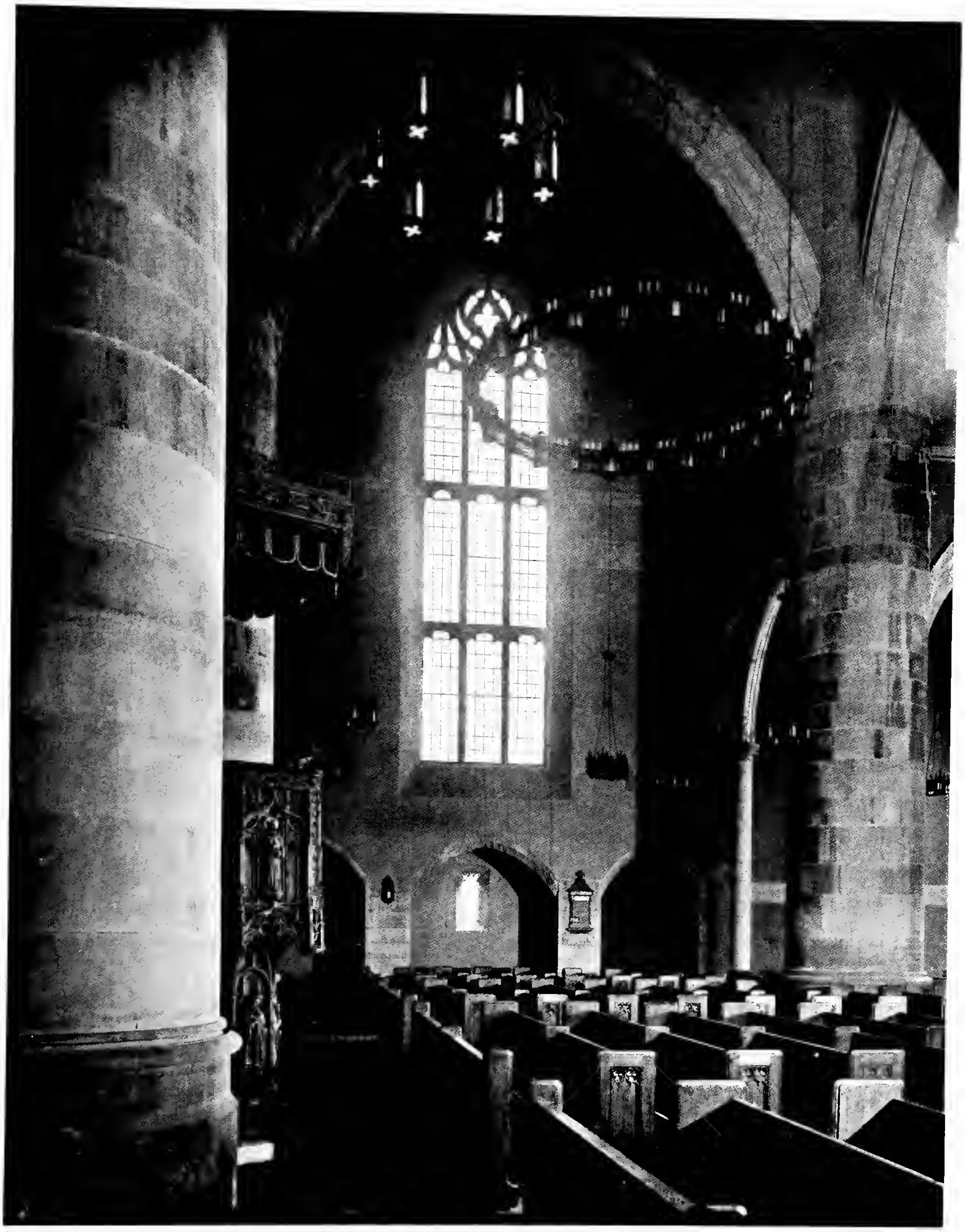
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

ST. PAUL'S CATHEDRAL, DETROIT, MICH.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

ST. PAUL'S CATHEDRAL, DETROIT, MICH.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



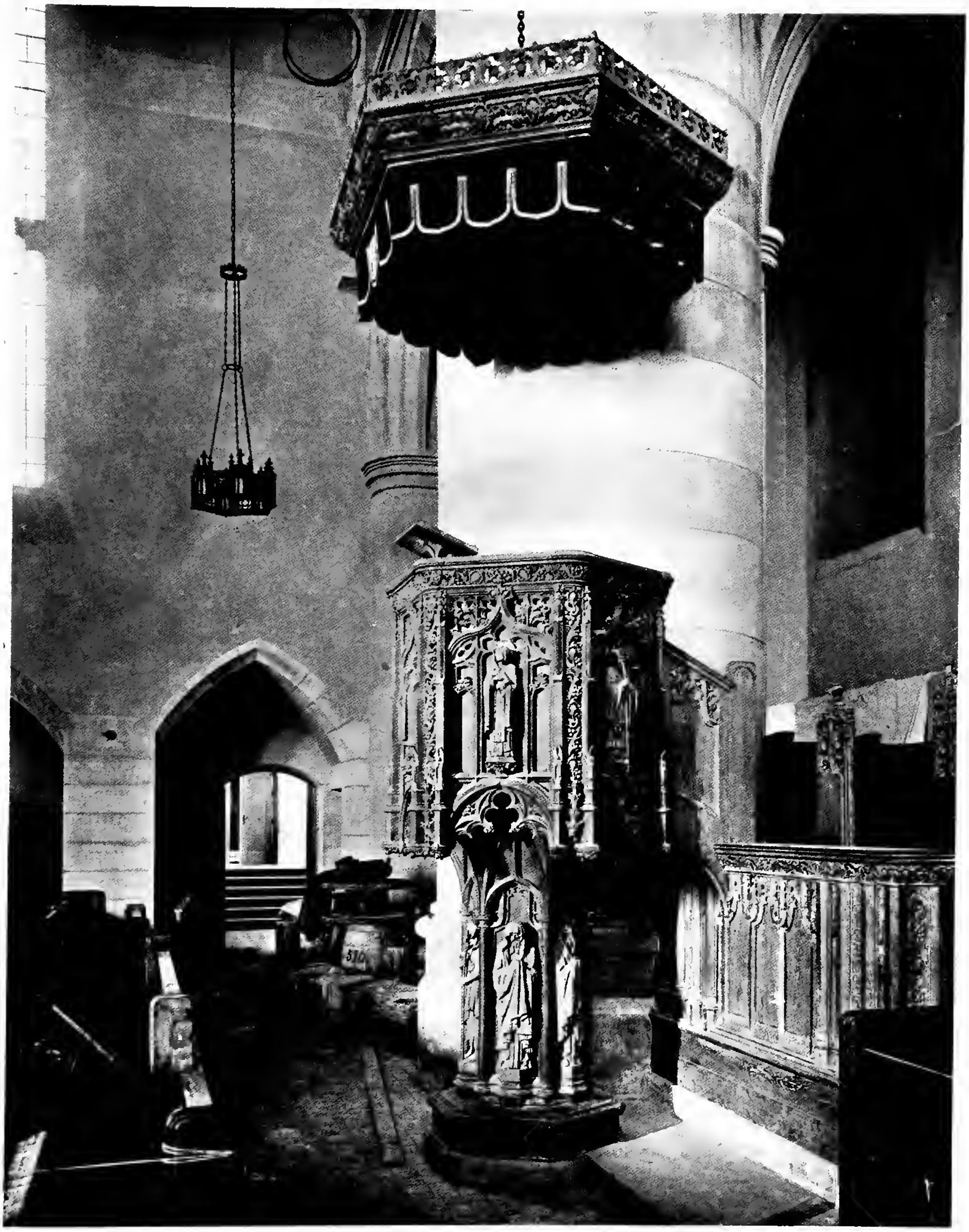
ST. PAUL'S CATHEDRAL, DETROIT, MICH.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

ALTAR AND REREDOS

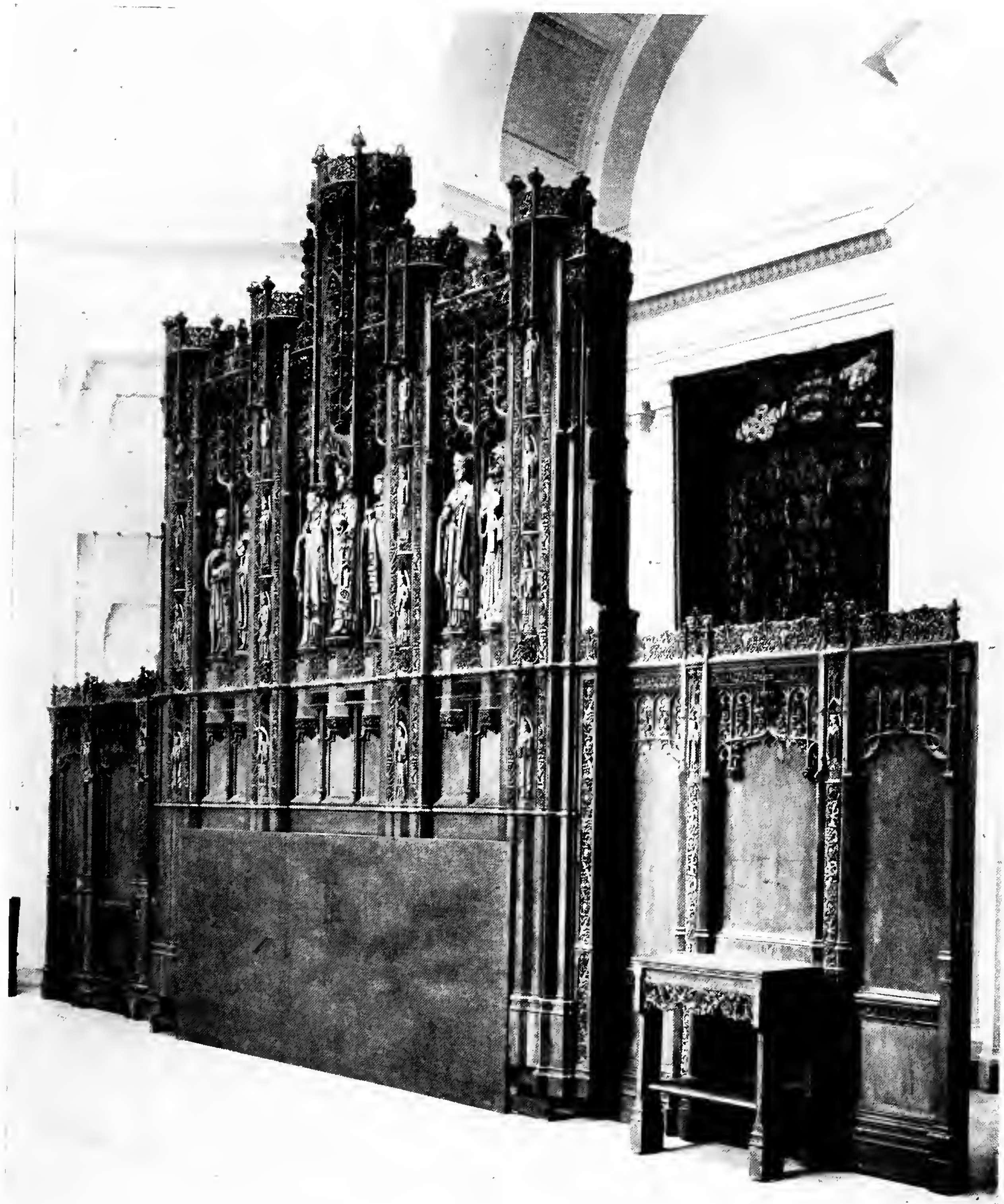
ST. PAUL'S CATHEDRAL, DETROIT, MICH.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



ST. PAUL'S CATHEDRAL, DETROIT, MICH.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



REREDOS, ST. PAUL'S CATHEDRAL, DETROIT, MICH.

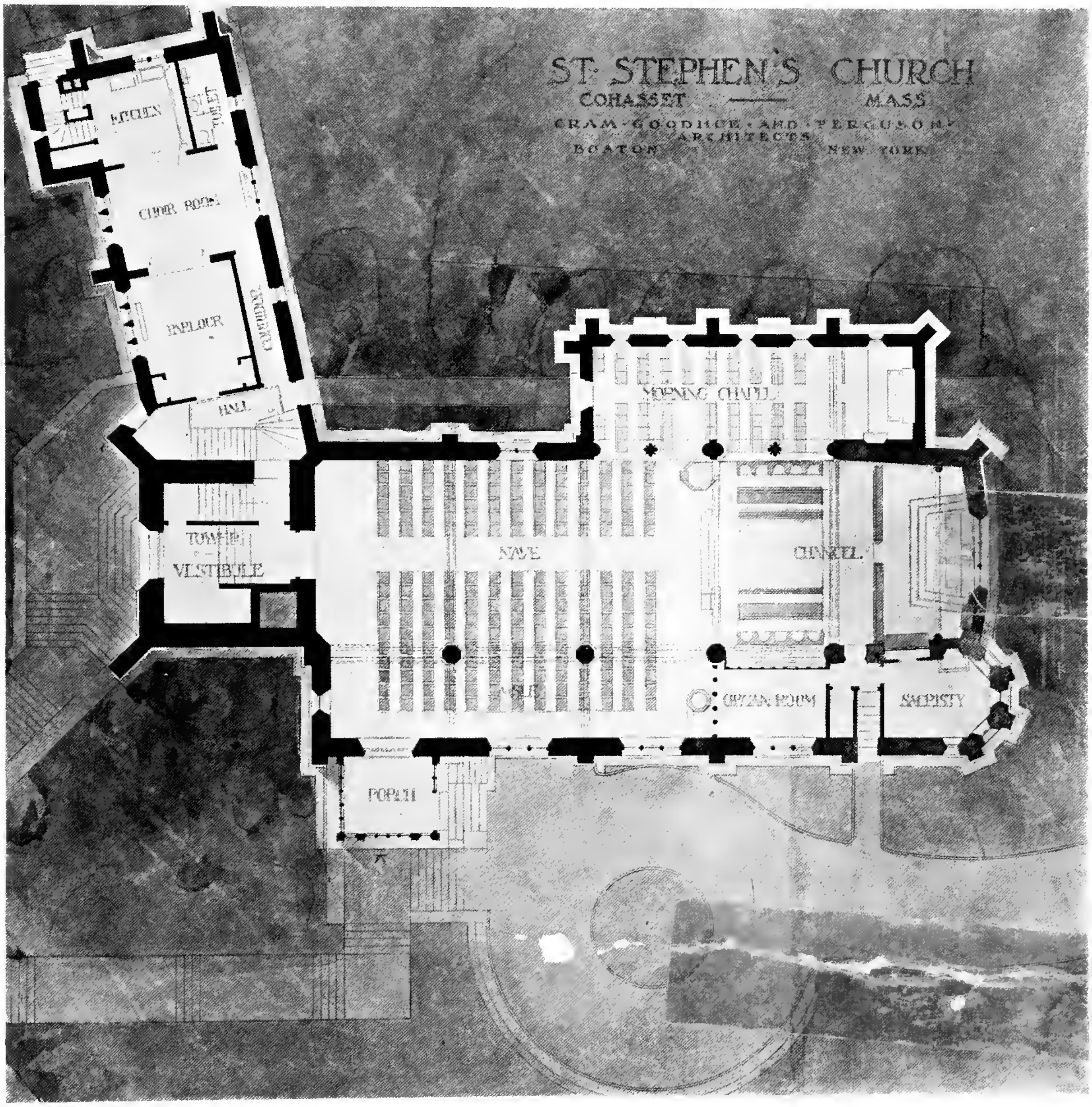
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

BISHOP'S THRONE

ST. PAUL'S CATHEDRAL, DETROIT, MICH.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

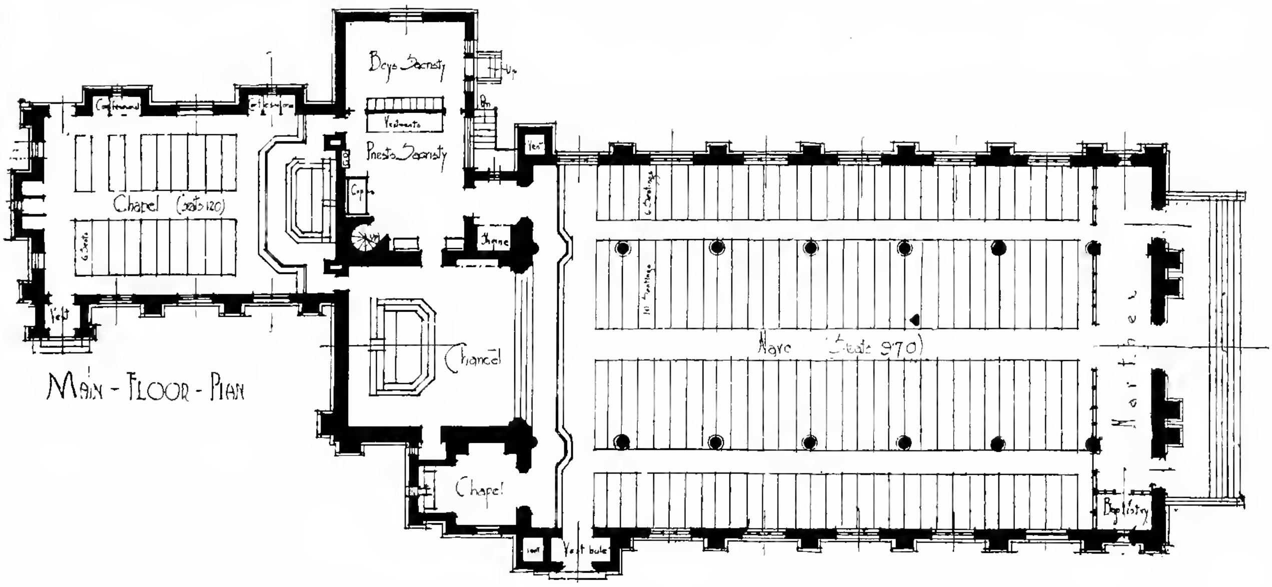
ST. STEPHEN'S CHURCH, COHASSET, MASS.
MESSRS. CRAM, GOODHUE & FERGUSON, *ARCHITECTS*



ST. STEPHEN'S CHURCH, COHASSET, MASS.

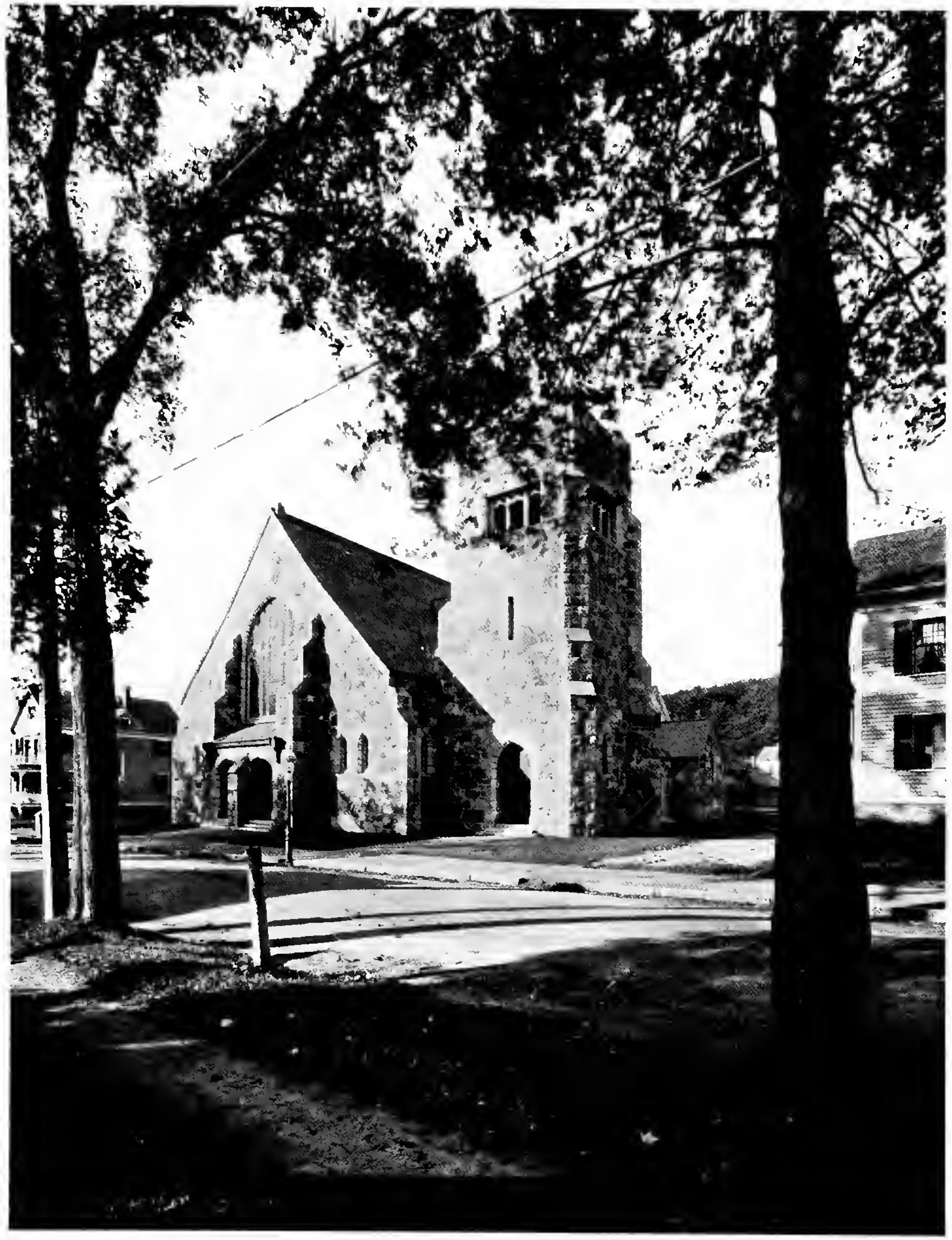
MESSRS. CRAM, GOODHUE & FERGUSON, *ARCHITECTS*

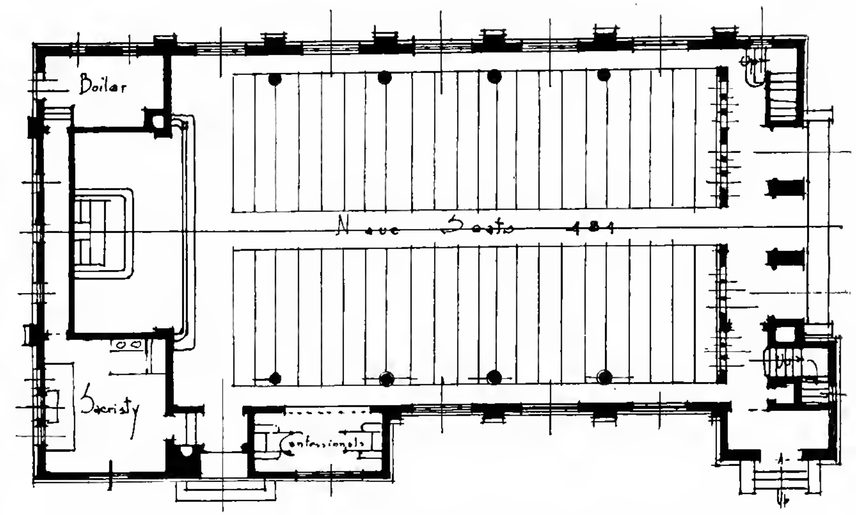
ST. CATHERINE'S CHURCH, NORWOOD, MASS.
MESSRS. MAGINNIS & WALSH, *ARCHITECTS*



ST. CATHERINE'S CHURCH, NORWOOD, MASS.

MESSRS. MAGINNIS & WALSH, *ARCHITECTS*



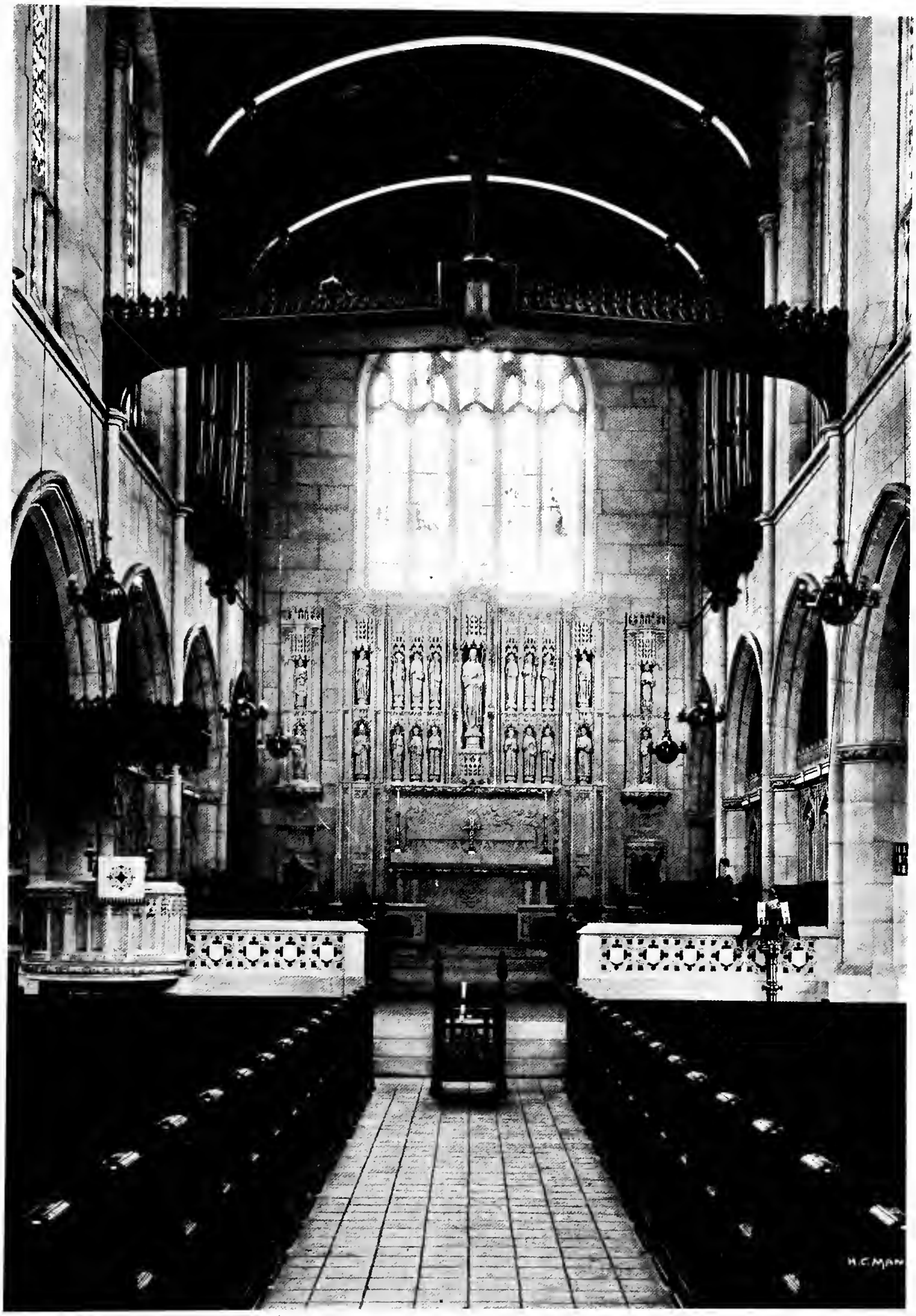


CHURCH OF THE SACRED HEART,
MANCHESTER BY THE SEA, MASS.

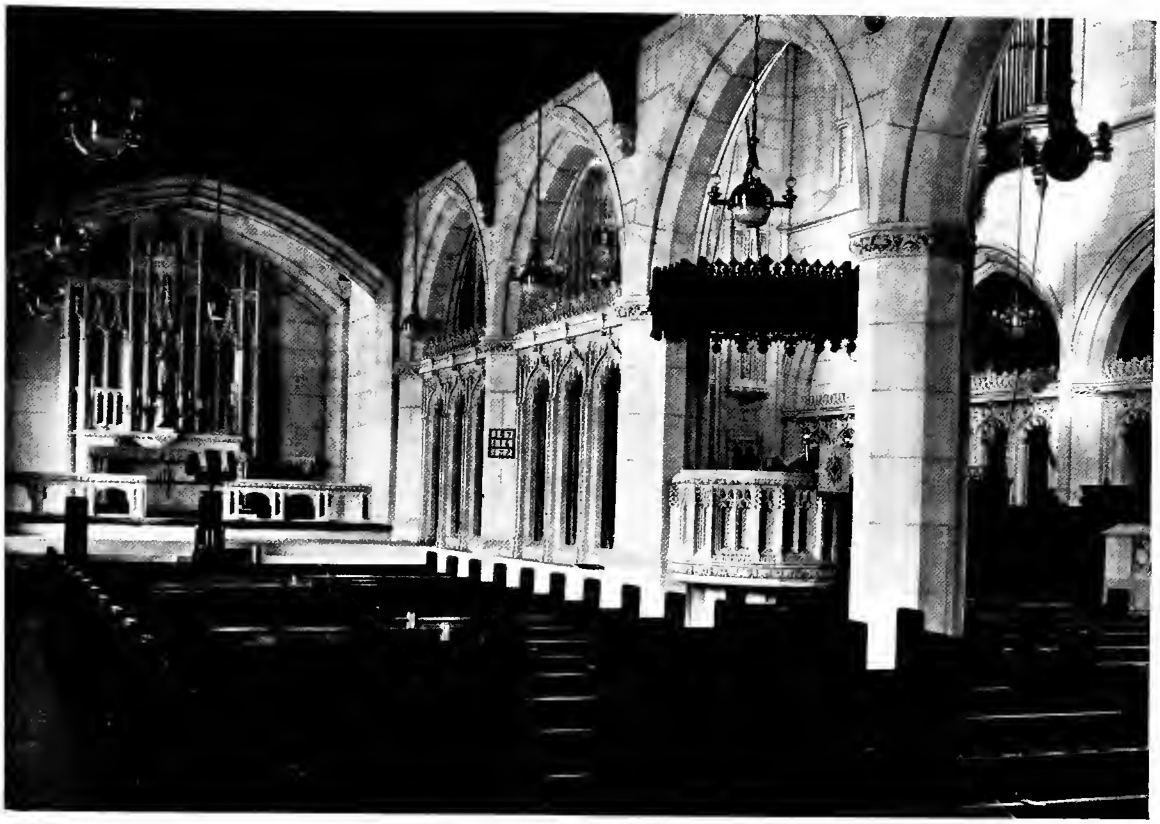
MESSRS. MAGINNIS, WALSH & SULLIVAN, *ARCHITECTS*

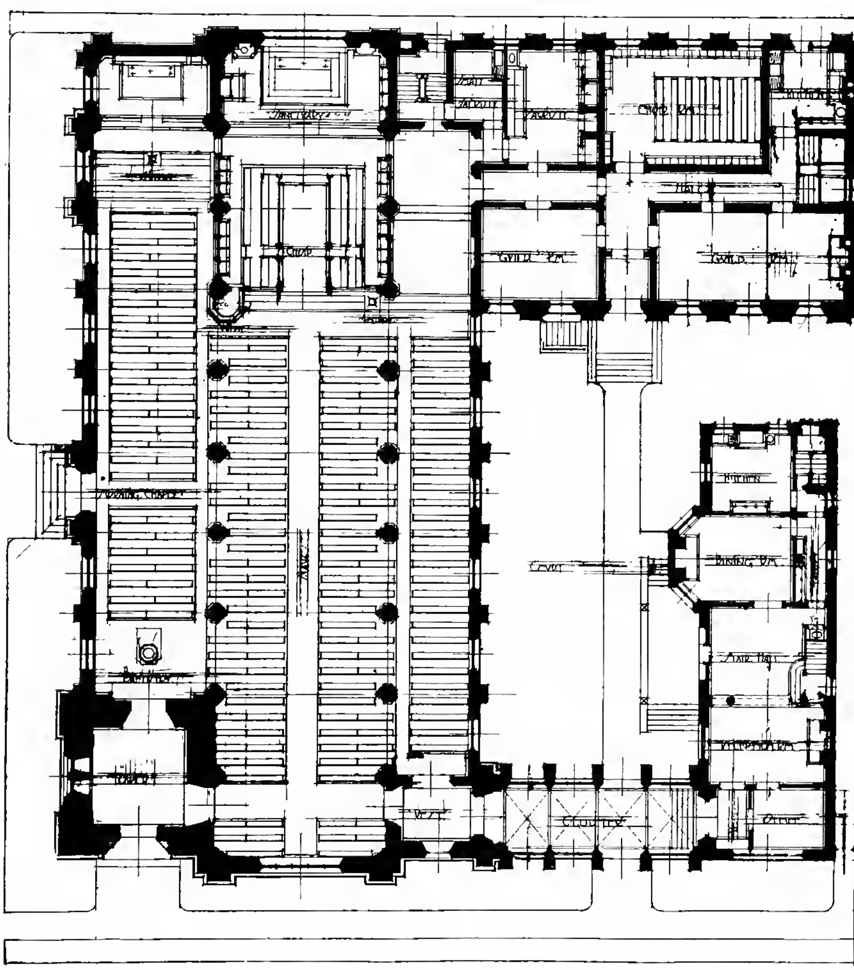
CHRIST CHURCH, NORFOLK, VA.

MESSRS. WATSON & HUCKEL, *ARCHITECTS*



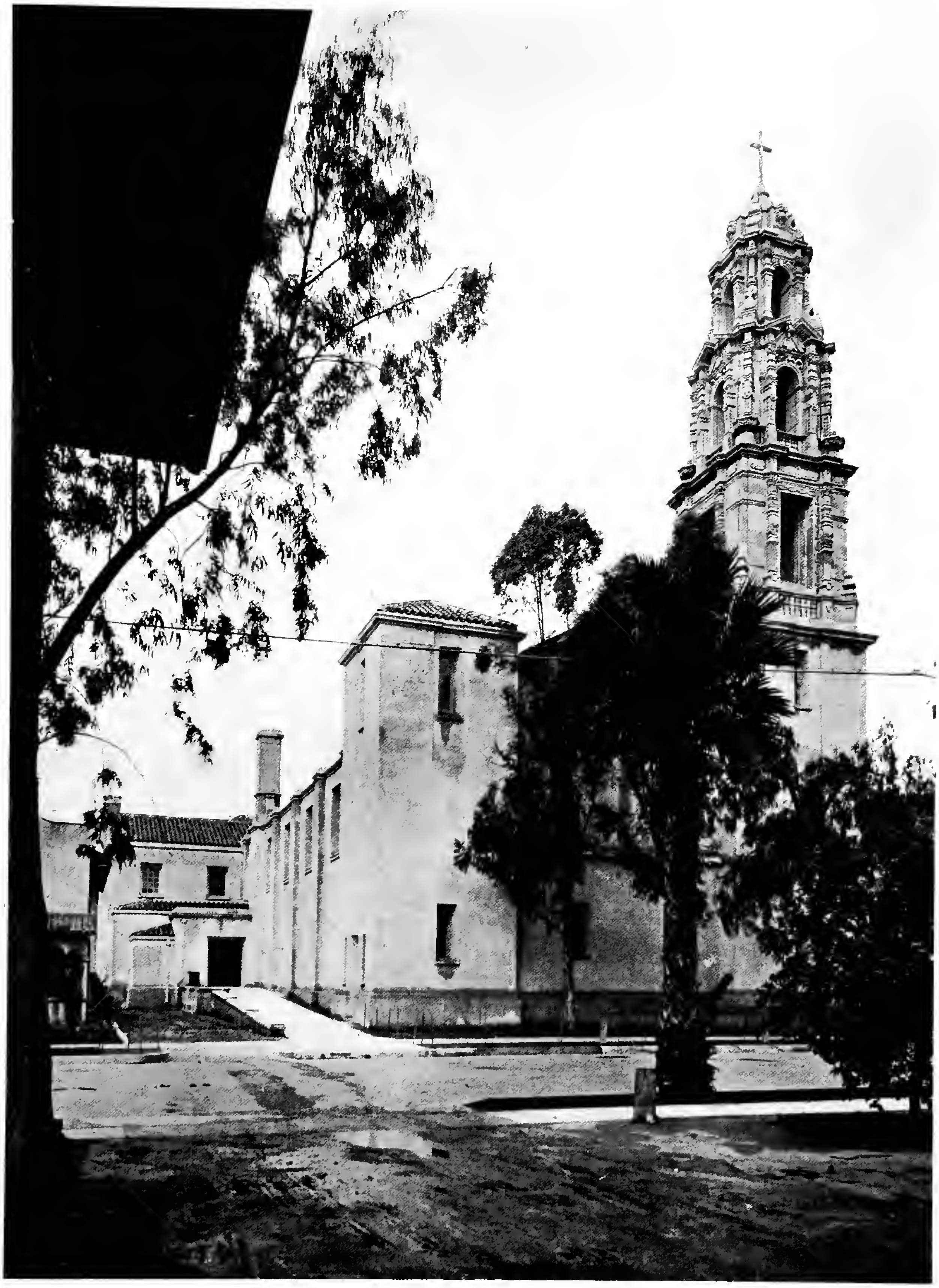
CHRIST CHURCH, NORFOLK, VA.
MESSRS. WATSON & HUCKEL, *ARCHITECTS*





CHRIST CHURCH, NORFOLK, VA.

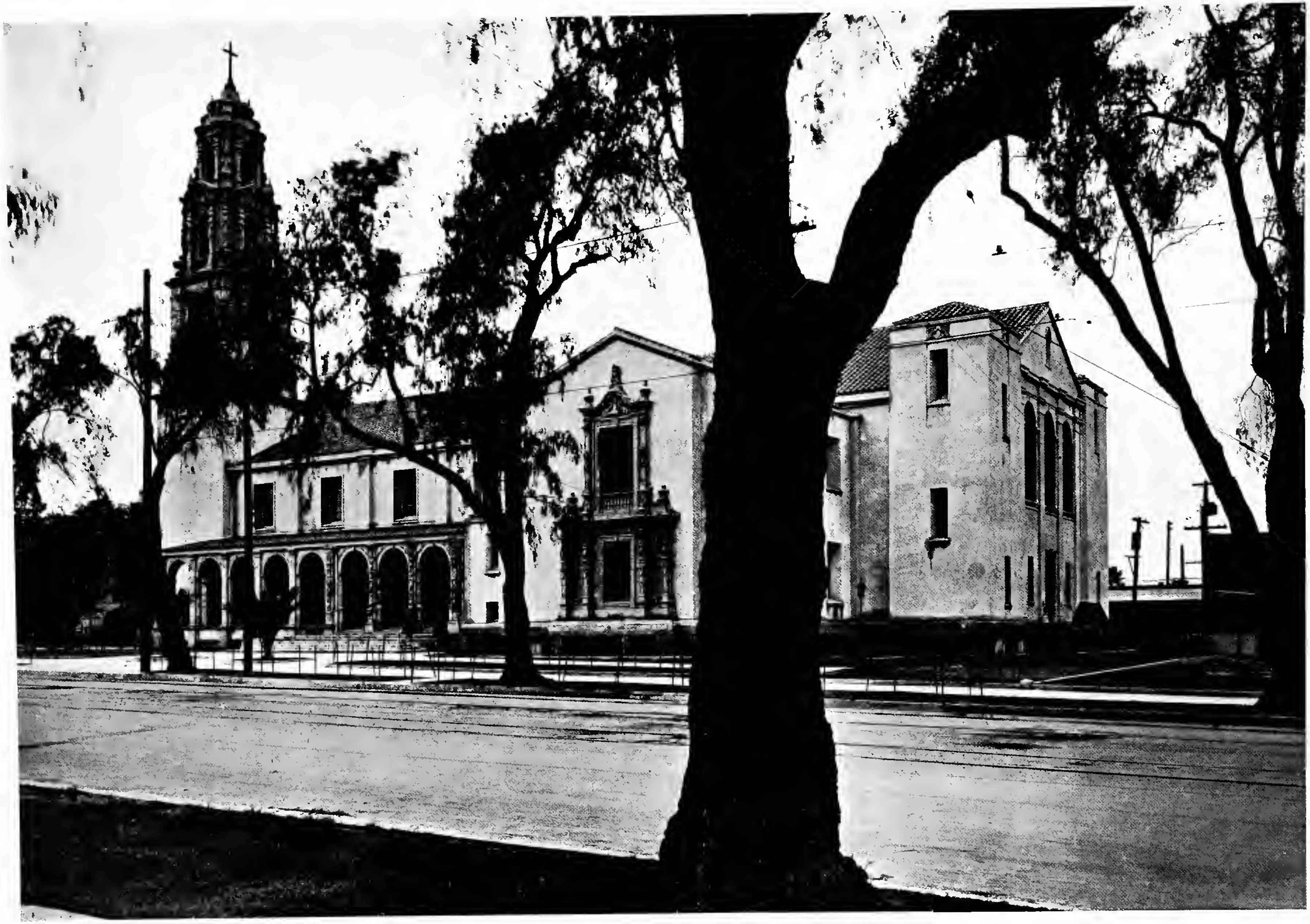
MESSRS. WATSON & HUCKEL, *ARCHITECTS*



VIEW FROM SOUTHEAST

FIRST CONGREGATIONAL CHURCH, RIVERSIDE, CAL.

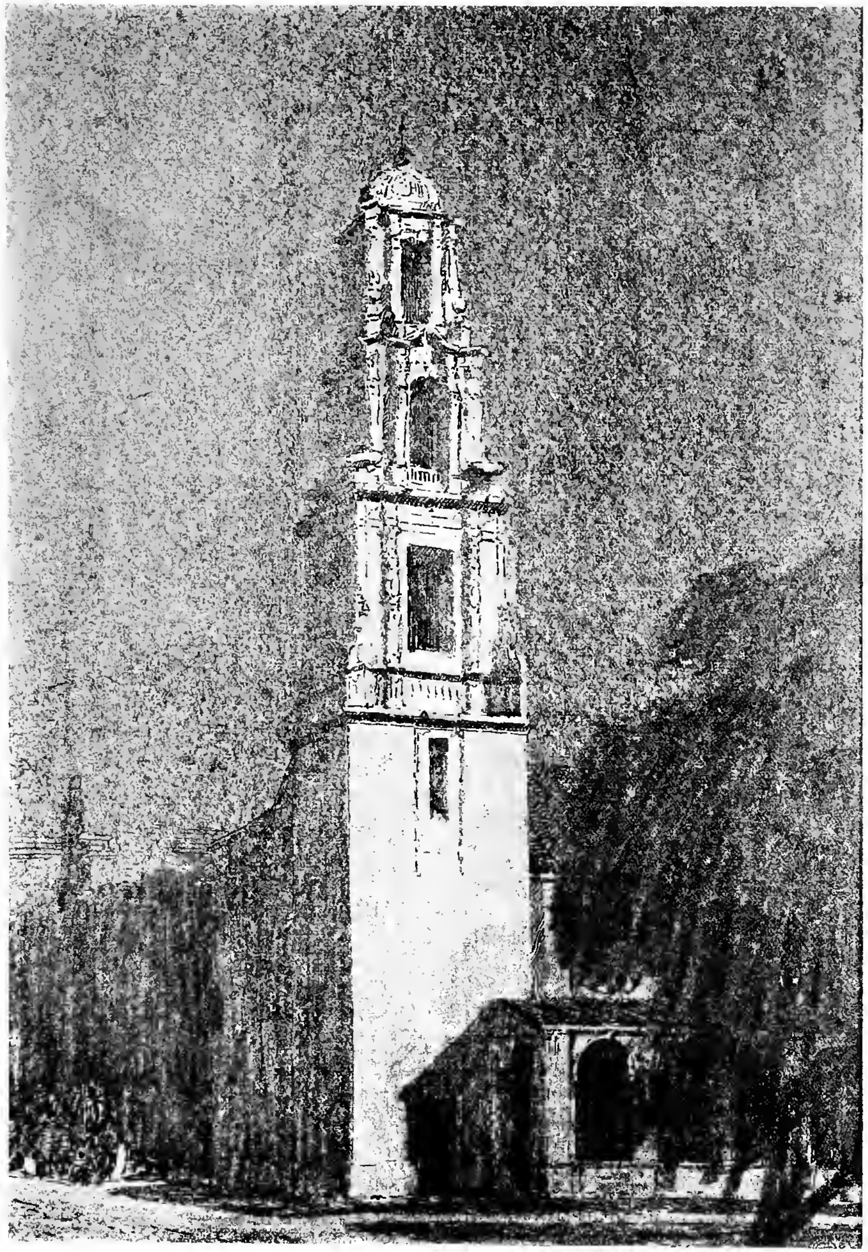
MR. MYRON HUNT, *ARCHITECT*



VIEW FROM NORTHWEST

FIRST CONGREGATIONAL CHURCH, RIVERSIDE, CAL.

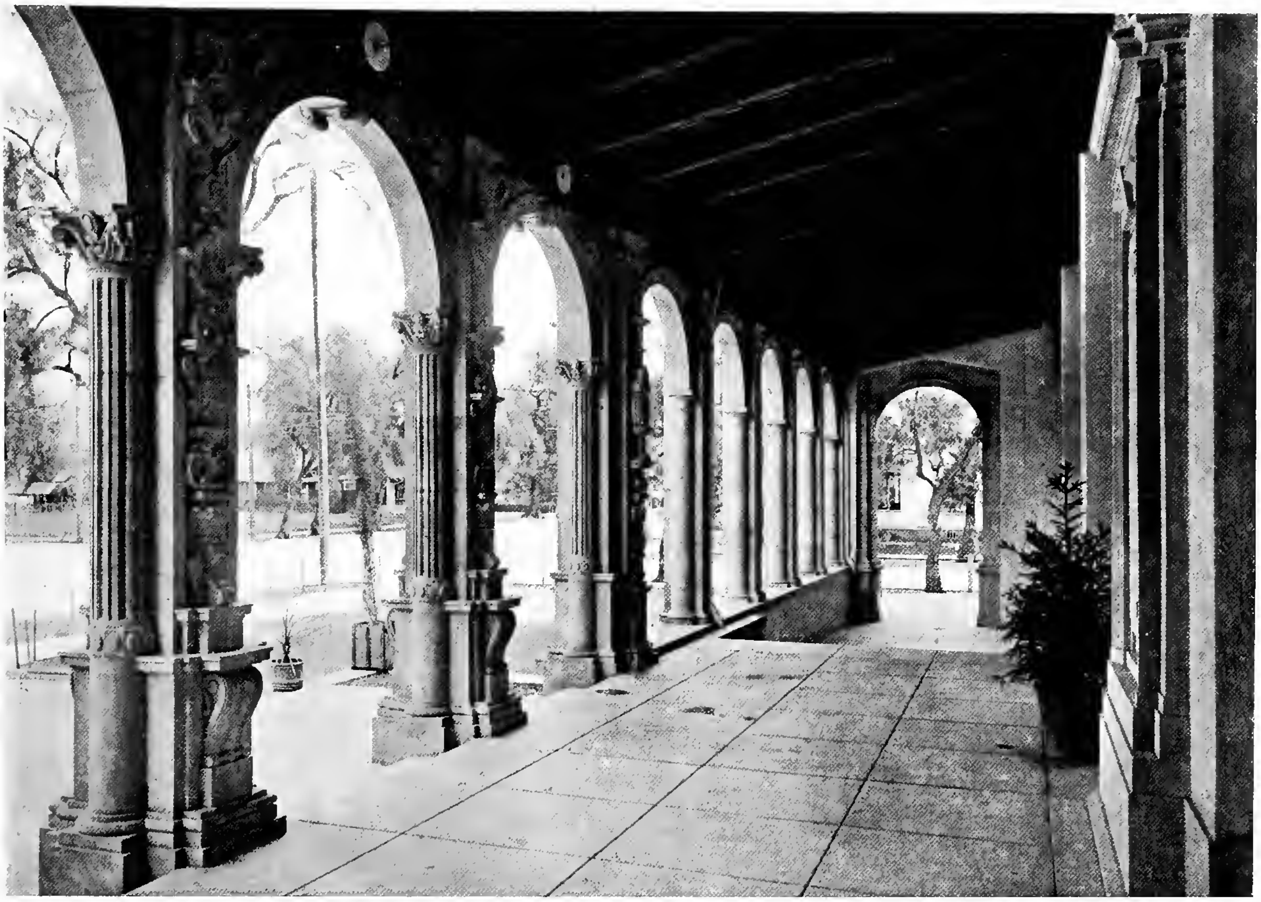
MR. MYRON HUNT, *ARCHITECT*



TENTATIVE SKETCH AND PHOTOGRAPHIC VIEW OF SPIRE

FIRST CONGREGATIONAL CHURCH, RIVERSIDE, CAL.

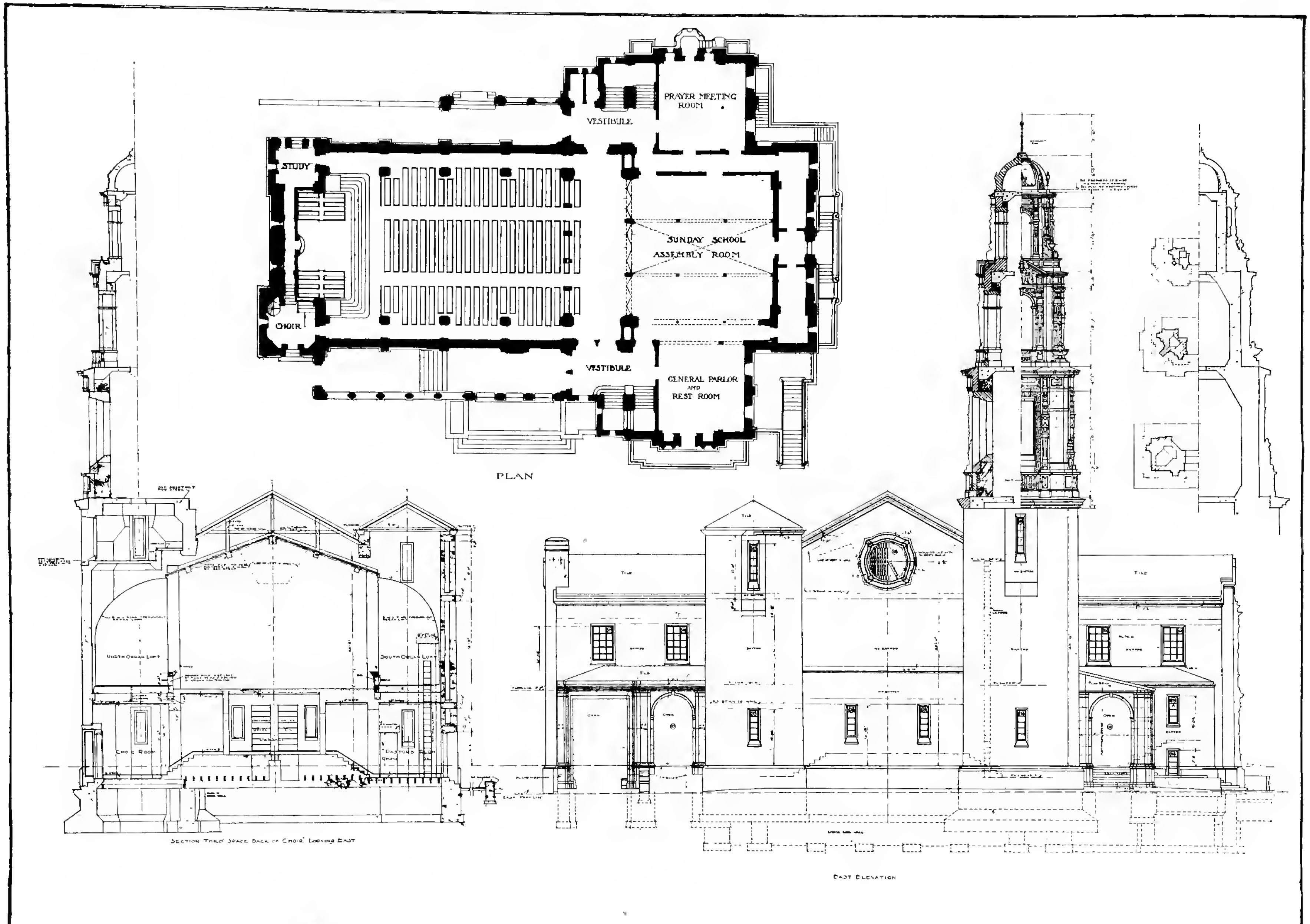
MR. MYRON HUNT, *ARCHITECT*



ARCADE

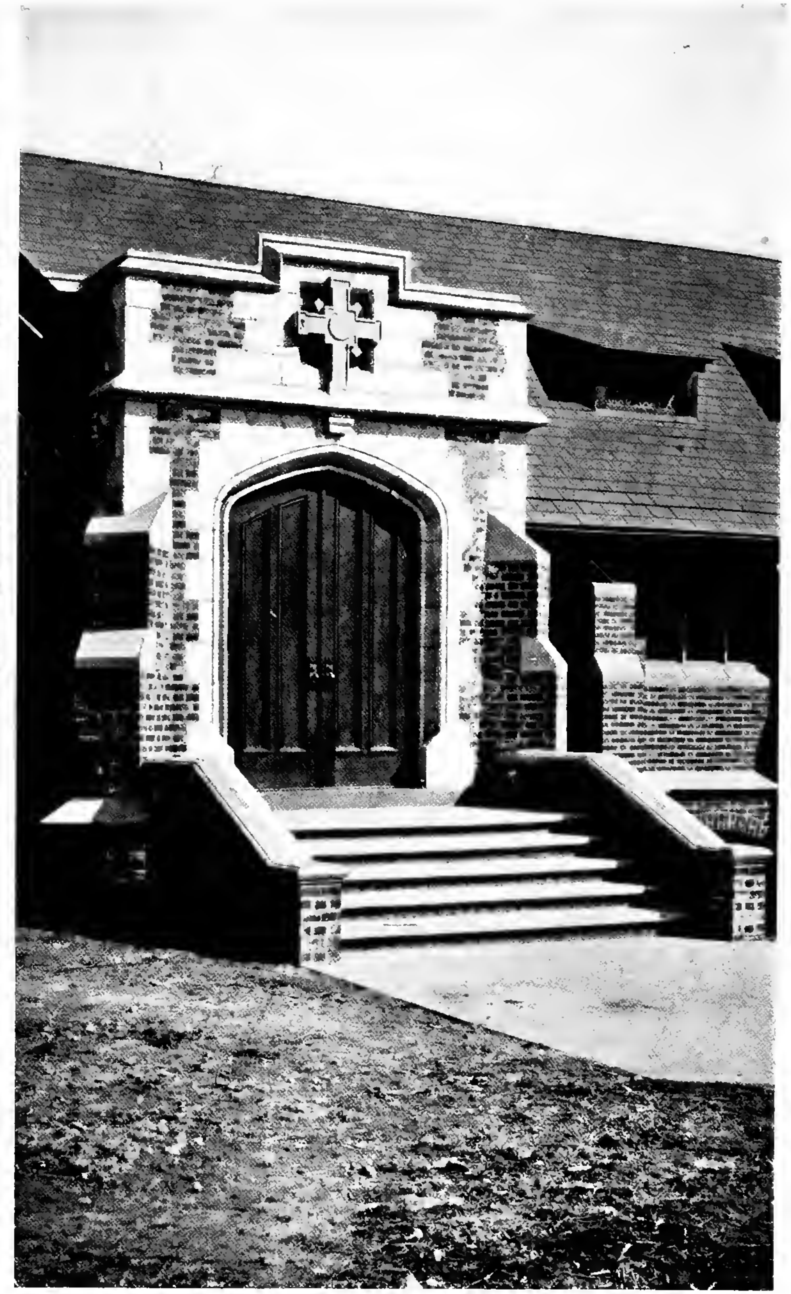
LOOKING TOWARD PULPIT

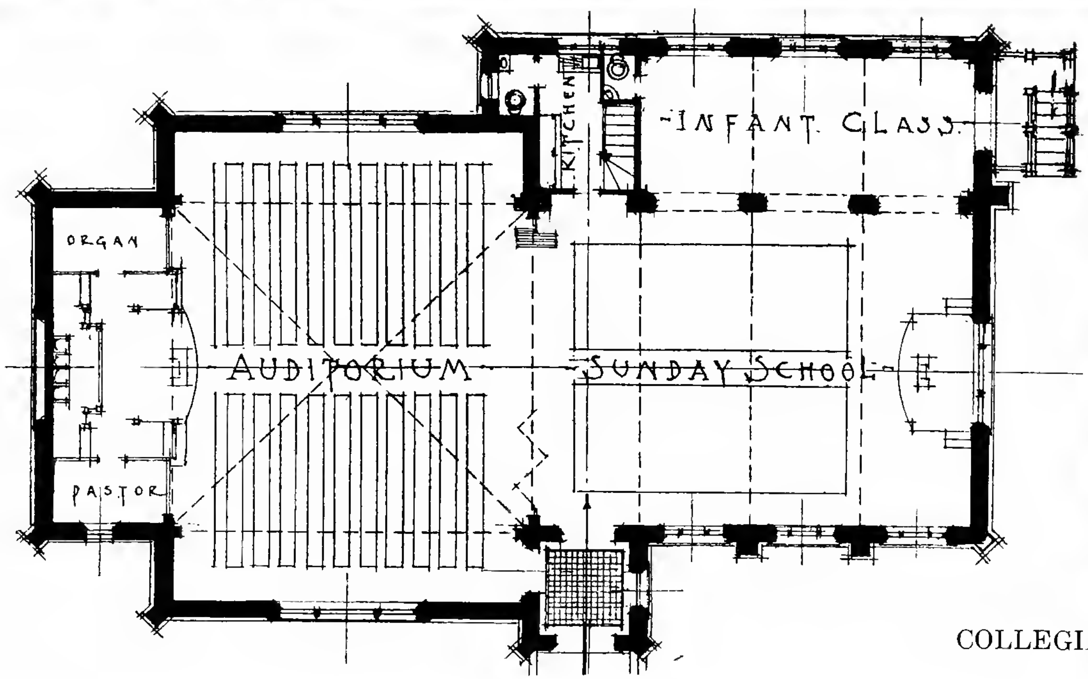
FIRST CONGREGATIONAL CHURCH, RIVERSIDE, CAL.
MR. MYRON HUNT, *ARCHITECT*



FIRST CONGREGATIONAL CHURCH, RIVERSIDE, CAL.

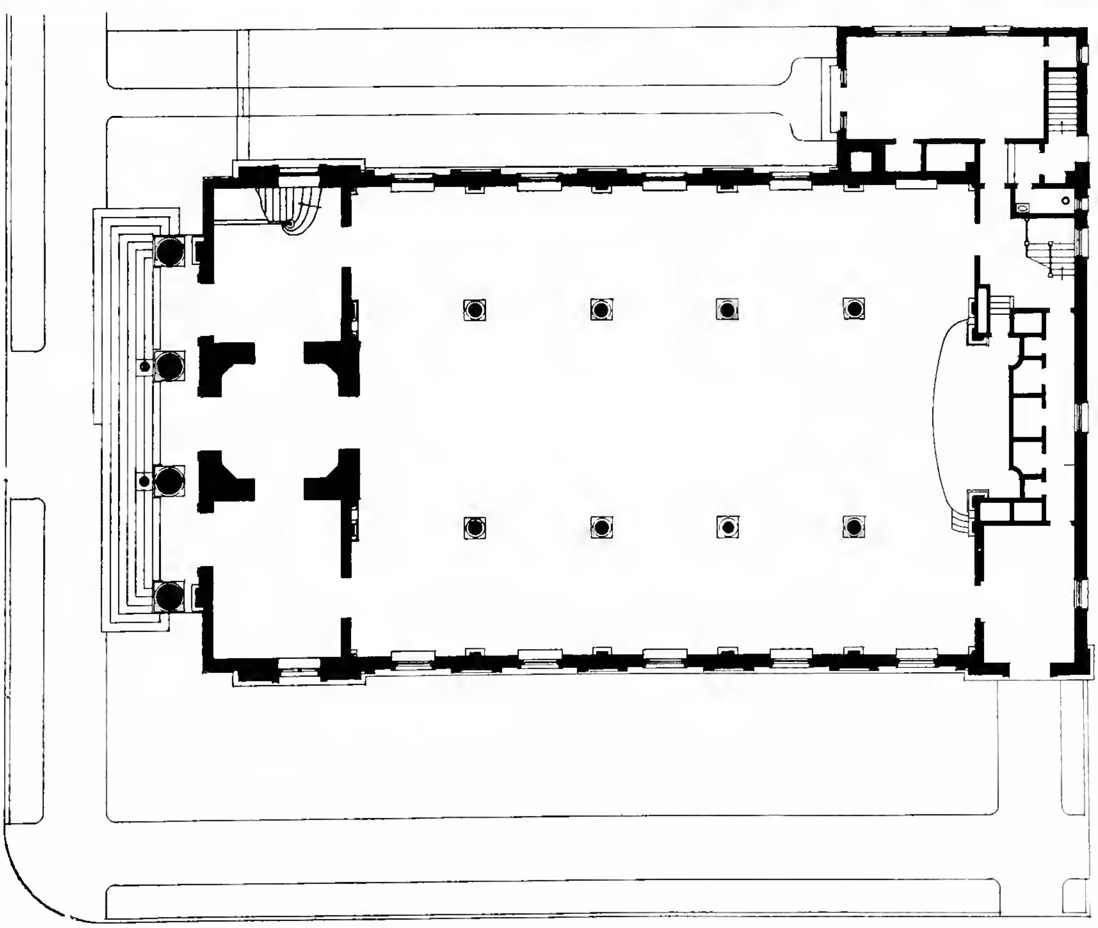
MR. MYRON HUNT, *ARCHITECT*





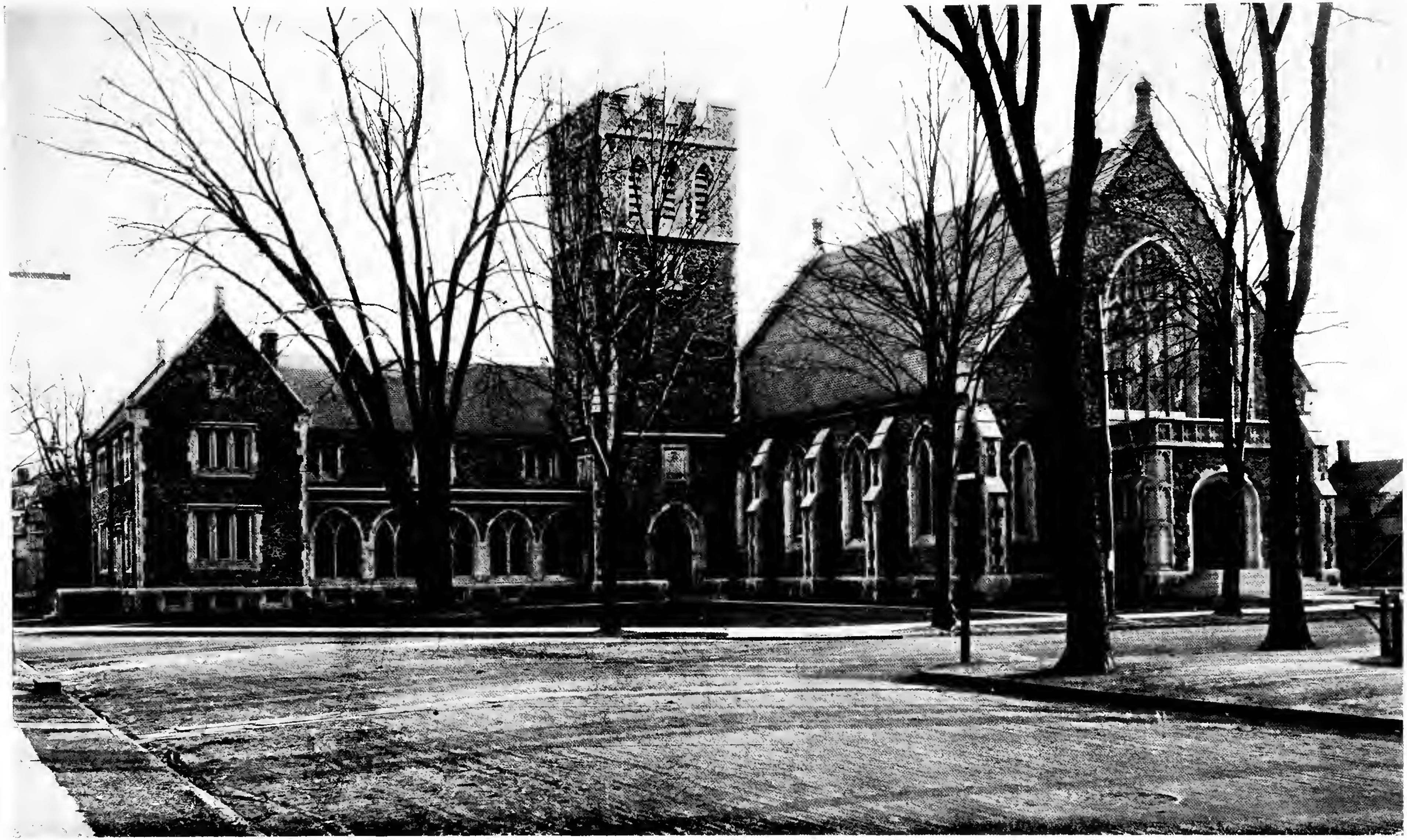
COLLEGIATE CHURCH, FORT WASHINGTON AVE., NEW YORK
MESSRS. NELSON & VAN WAGENEN, *ARCHITECTS*

FIRST PRESBYTERIAN CHURCH, ST. JOSEPH, MO.
MESSRS. ECKEL & BOSCHEN, *ARCHITECTS*



FIRST PRESBYTERIAN CHURCH, ST. JOSEPH, MO.
MESSRS. ECKEL & BOSCHEN, *ARCHITECTS*

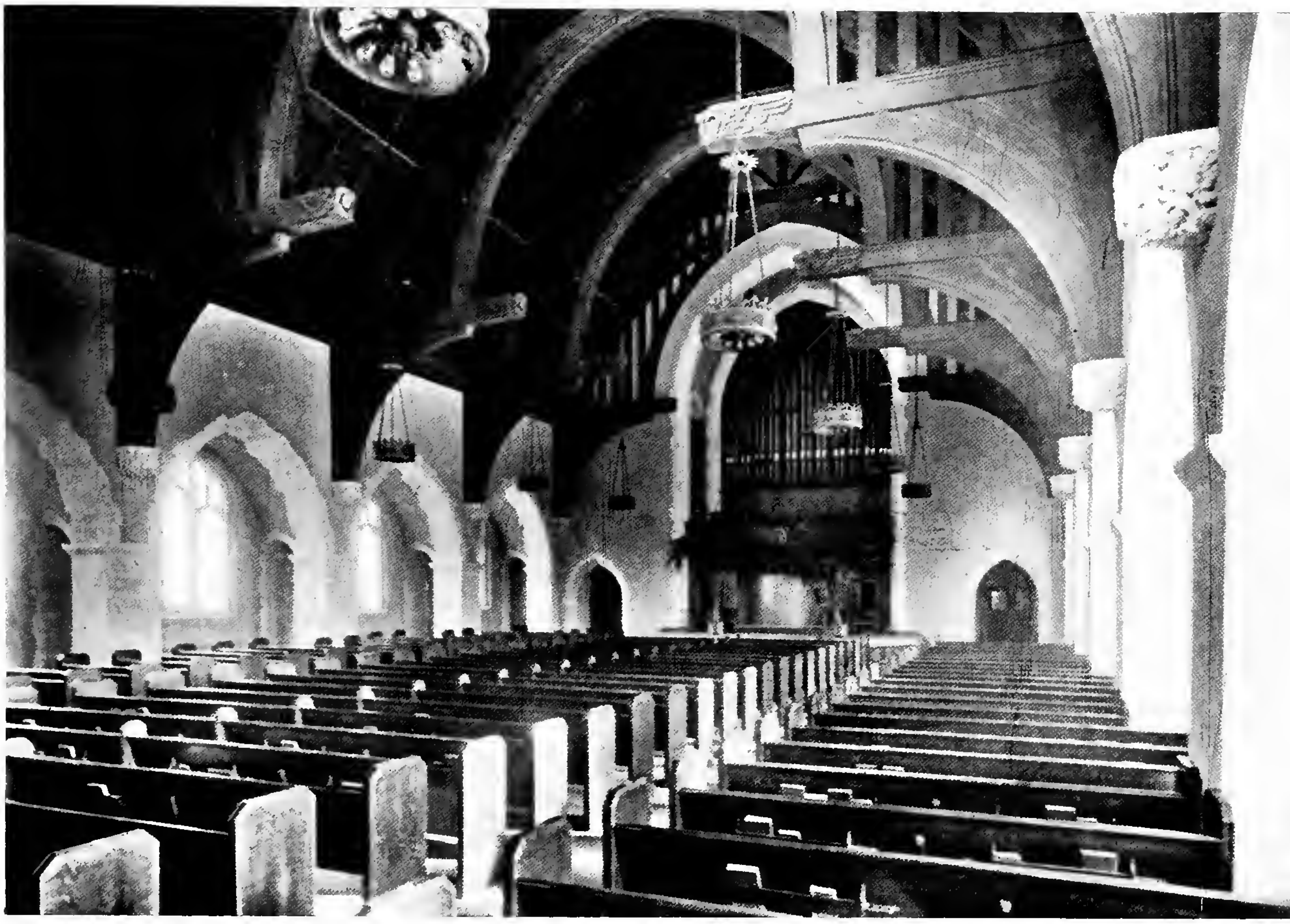
FIRST PRESBYTERIAN CHURCH, ST. JOSEPH, MO.
MESSRS. ECKEL & BOSCHEN, *ARCHITECTS*

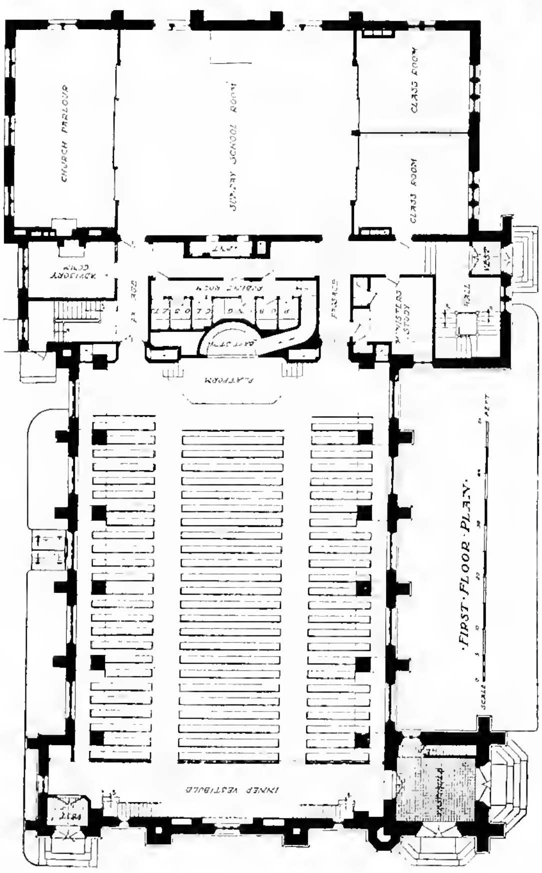


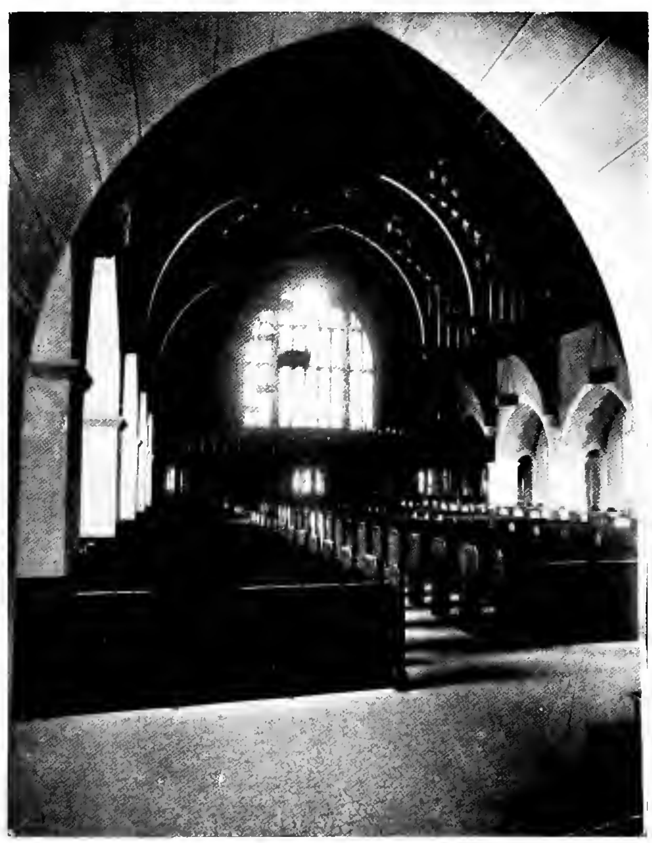
SECOND REFORMED CHURCH, HACKENSACK, N. J.

MESSRS. EDWARD PEARCE CASEY AND A. DURANT SNEDEN, *ASSOCIATE ARCHITECTS*

BAPTIST CHURCH, BROOKLINE, MASS.
MR. J. A. SCHWEINFURTH, *ARCHITECT*

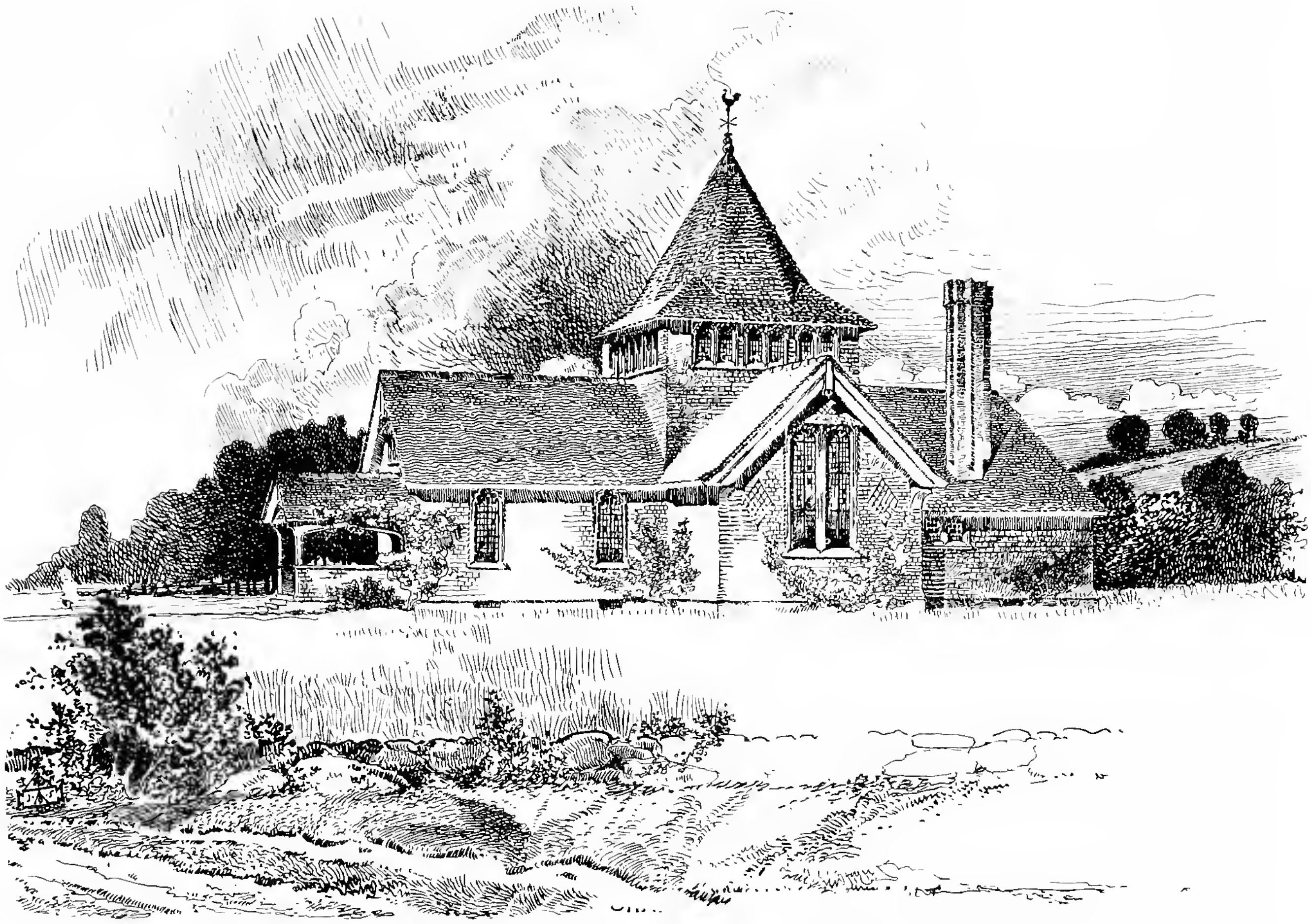


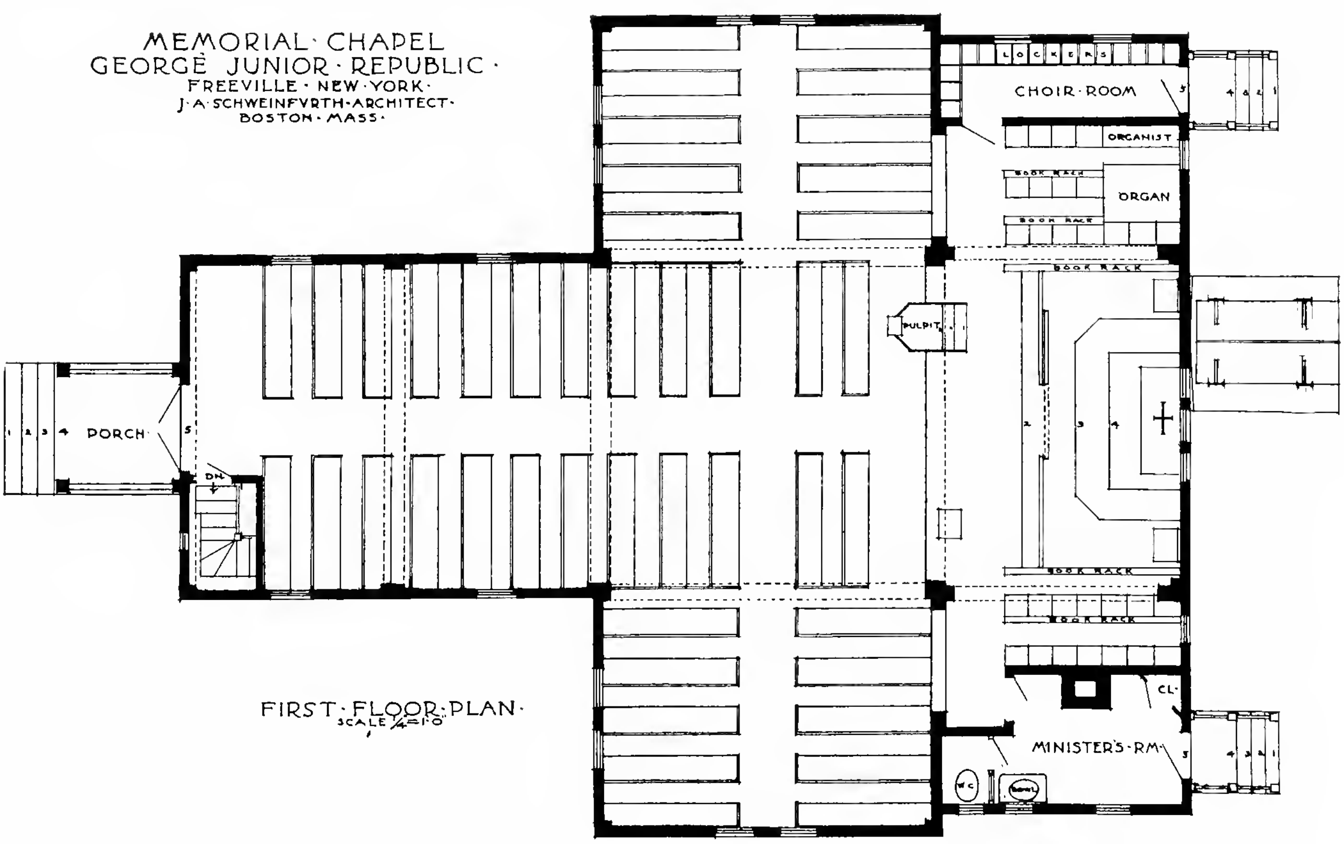




BAPTIST CHURCH, BROOKLINE, MASS.

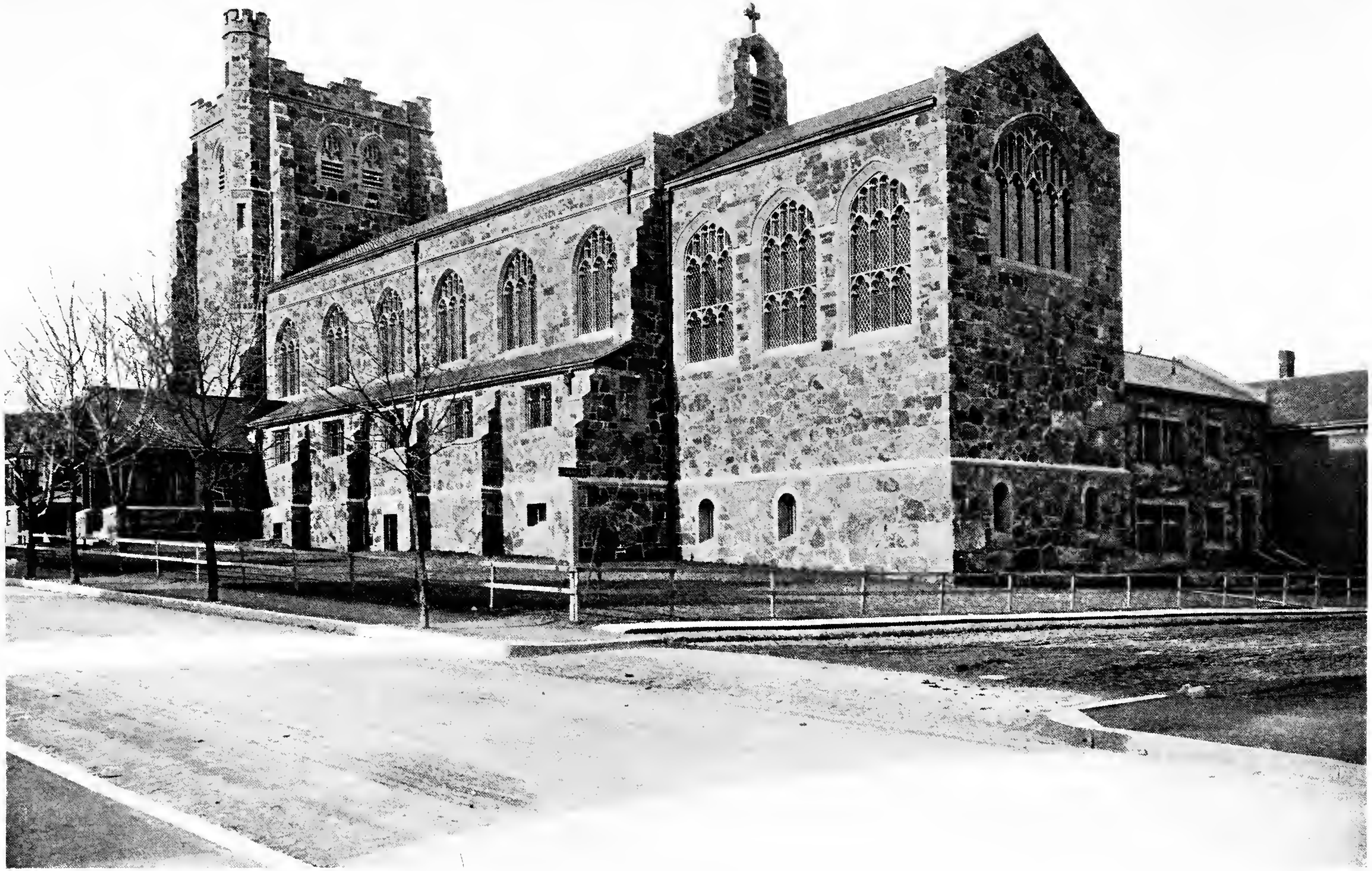
MR. J. A. SCHWEINFURTH, *ARCHITECT*





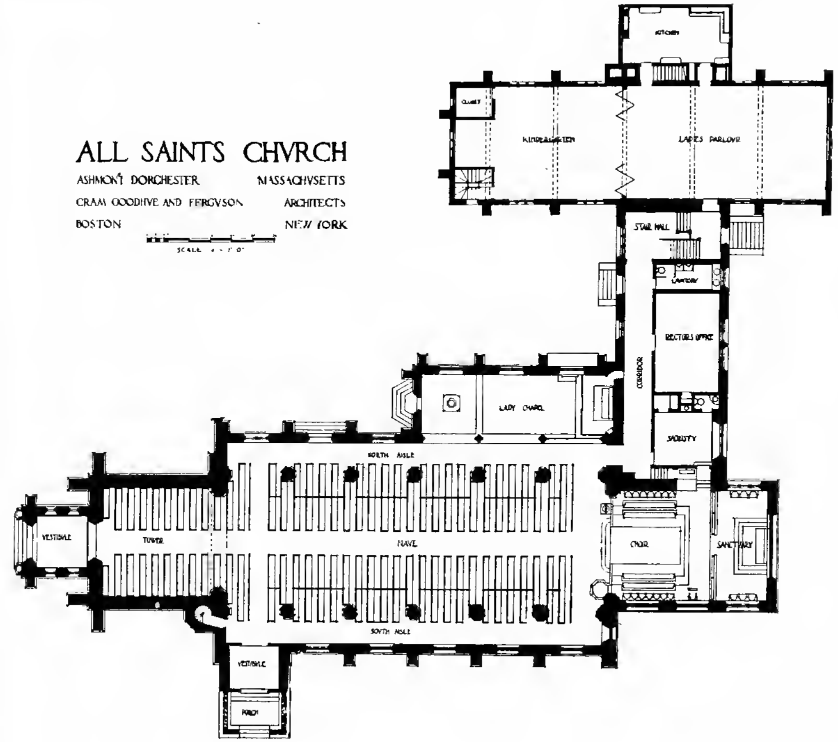
MEMORIAL·CHAPEL
GEORGE JUNIOR·REPUBLIC·
FREEVILLE·NEW·YORK·
J·A·SCHWEINFURTH·ARCHITECT·
BOSTON·MASS·

FIRST·FLOOR·PLAN·
SCALE 1/4"=1'0"



ALL SAINTS CHURCH, ASHMONT, DORCHESTER, MASS.
MESSRS. CRAM, GOODHUE & FERGUSON, *ARCHITECTS*

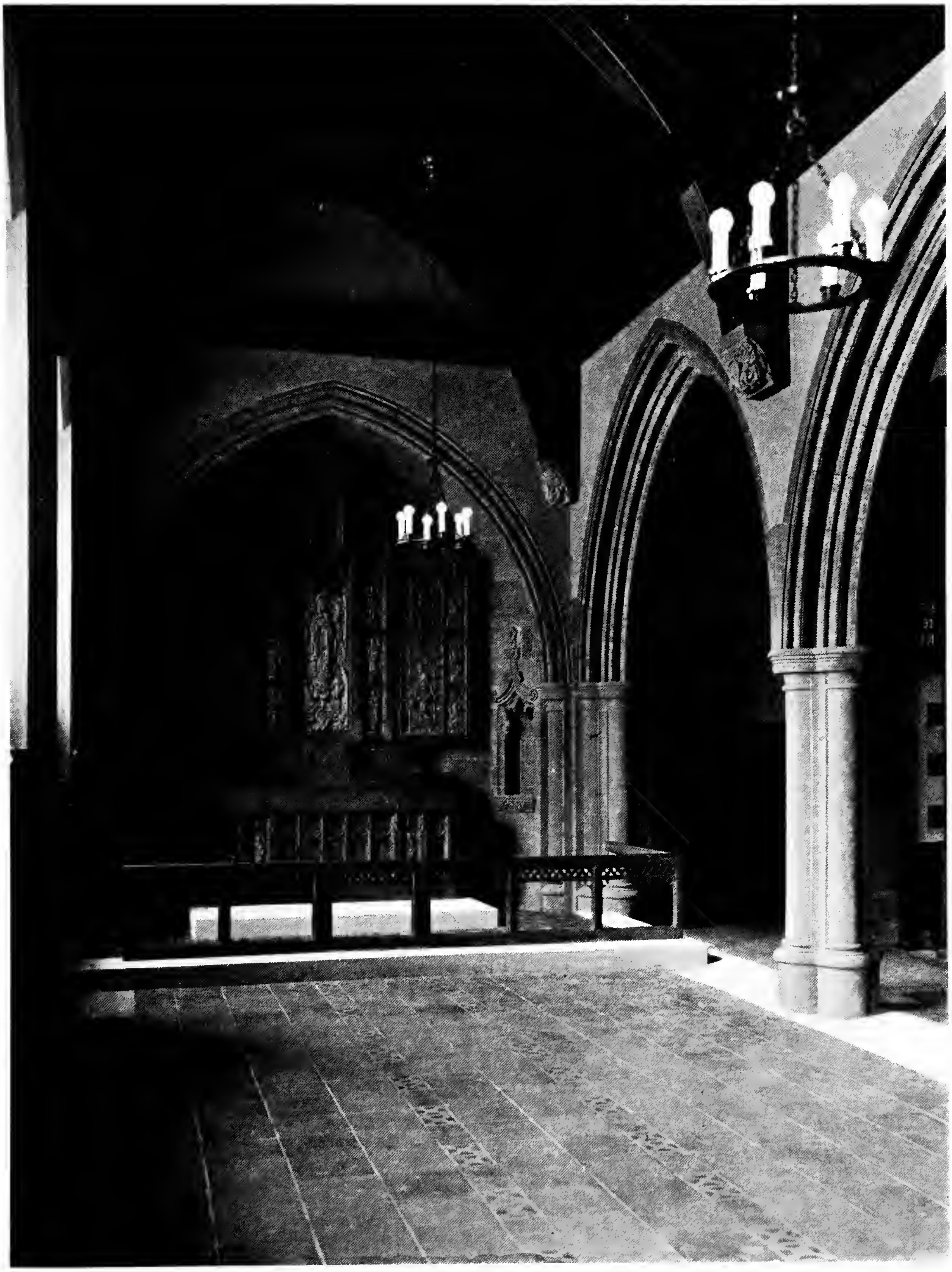
LADY CHAPEL



ALL SAINTS CHURCH
ASHMONT, DORCHESTER, MASS.

MESSRS. CRAM, GOODHUE & FERGUSON, *ARCHITECTS*

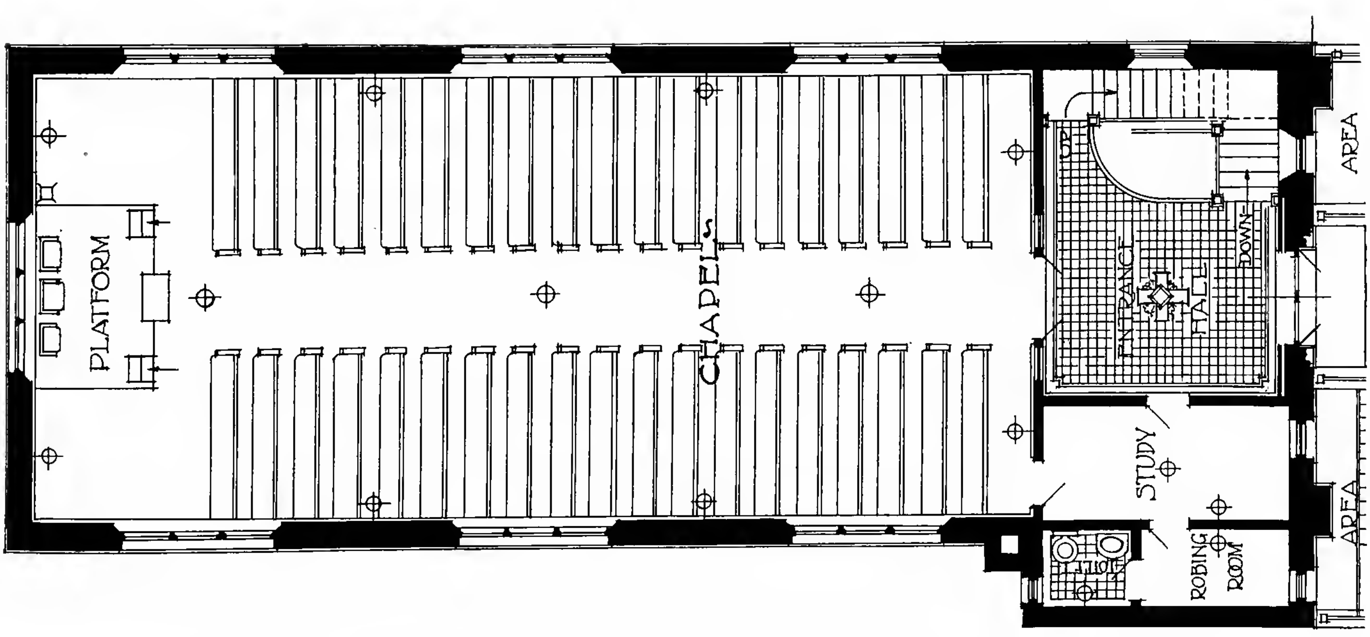
ALL SAINTS CHURCH, ASHMONT, DORCHESTER, MASS.
MESSRS. CRAM, GOODHUE & FERGUSON, *ARCHITECTS*



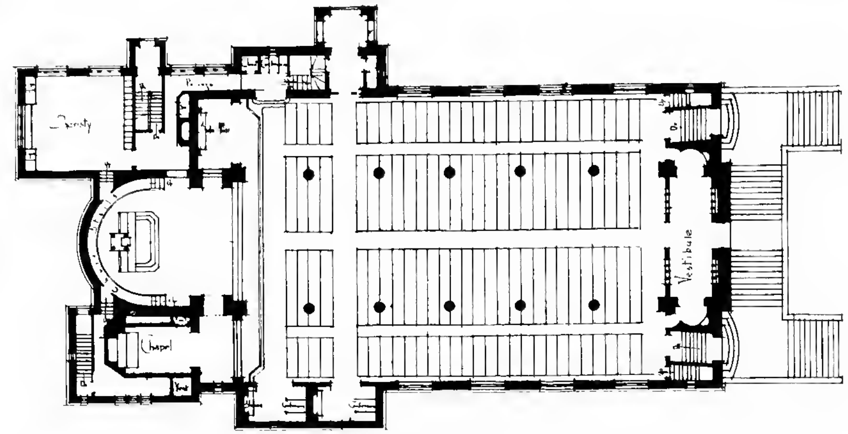
LADY CHAPEL

ALL SAINTS CHURCH, ASHMONT, DORCHESTER, MASS.

MESSRS. CRAM, GOODHUE & FERGUSON, *ARCHITECTS*

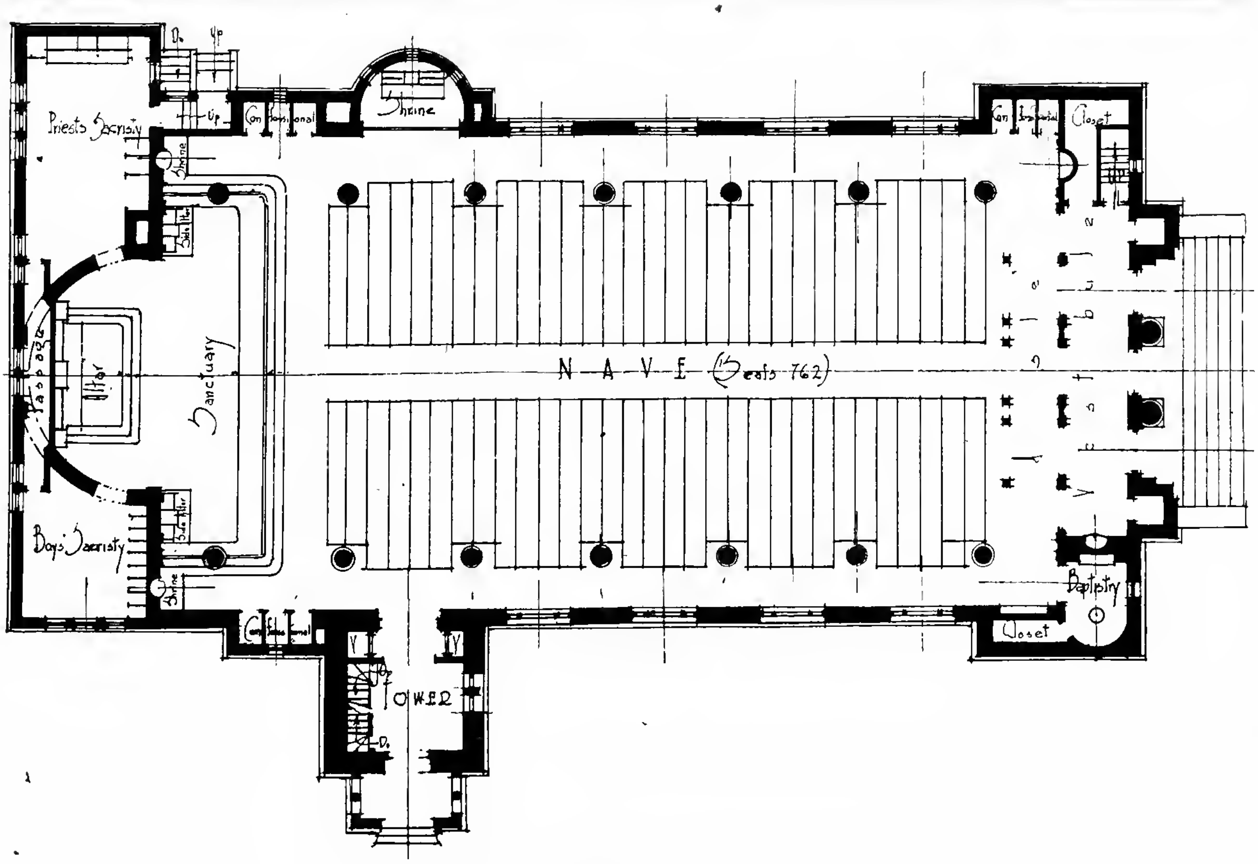


VAN NEST CHAPEL, NEW YORK, N. Y.
MESSRS. JAMES E. WARE & SONS, *ARCHITECTS*



ST. CATHERINE'S CHURCH,
SOMERVILLE, MASS.

MESSRS. MAGINNIS, WALSH & SULLIVAN, *ARCHITECTS*

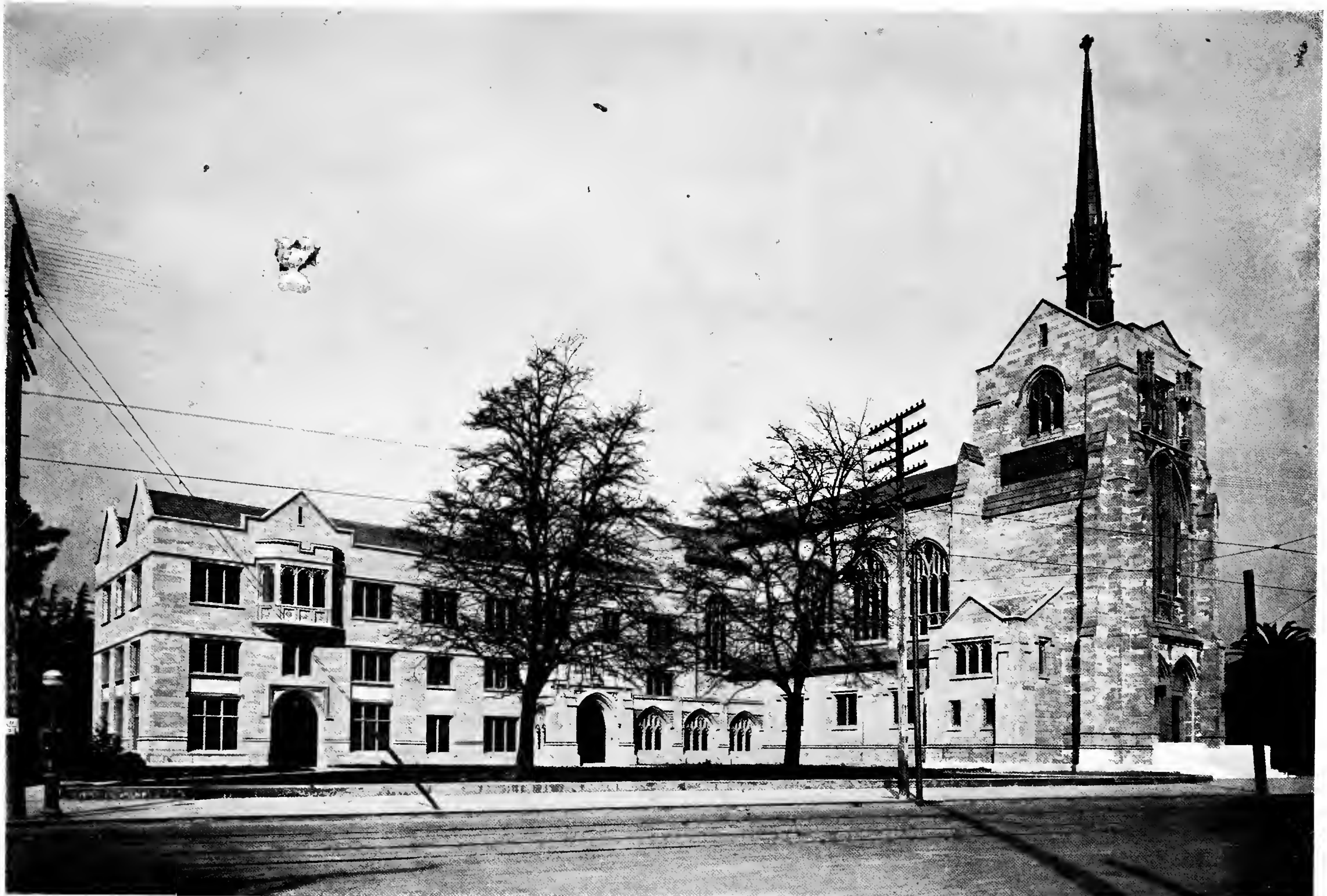


ST. JOSEPH'S CHURCH, DAYTON, OHIO

MESSRS. MAGINNIS & WALSH, *ARCHITECTS*

FIRST PRESBYTERIAN CHURCH, OAKLAND, CAL.

MR. WILLIAM C. HAYS, *ARCHITECT*, SAN FRANCISCO; MESSRS. CRAM, GOODHUE & FERGUSON, *CONSULTING ARCHITECTS*



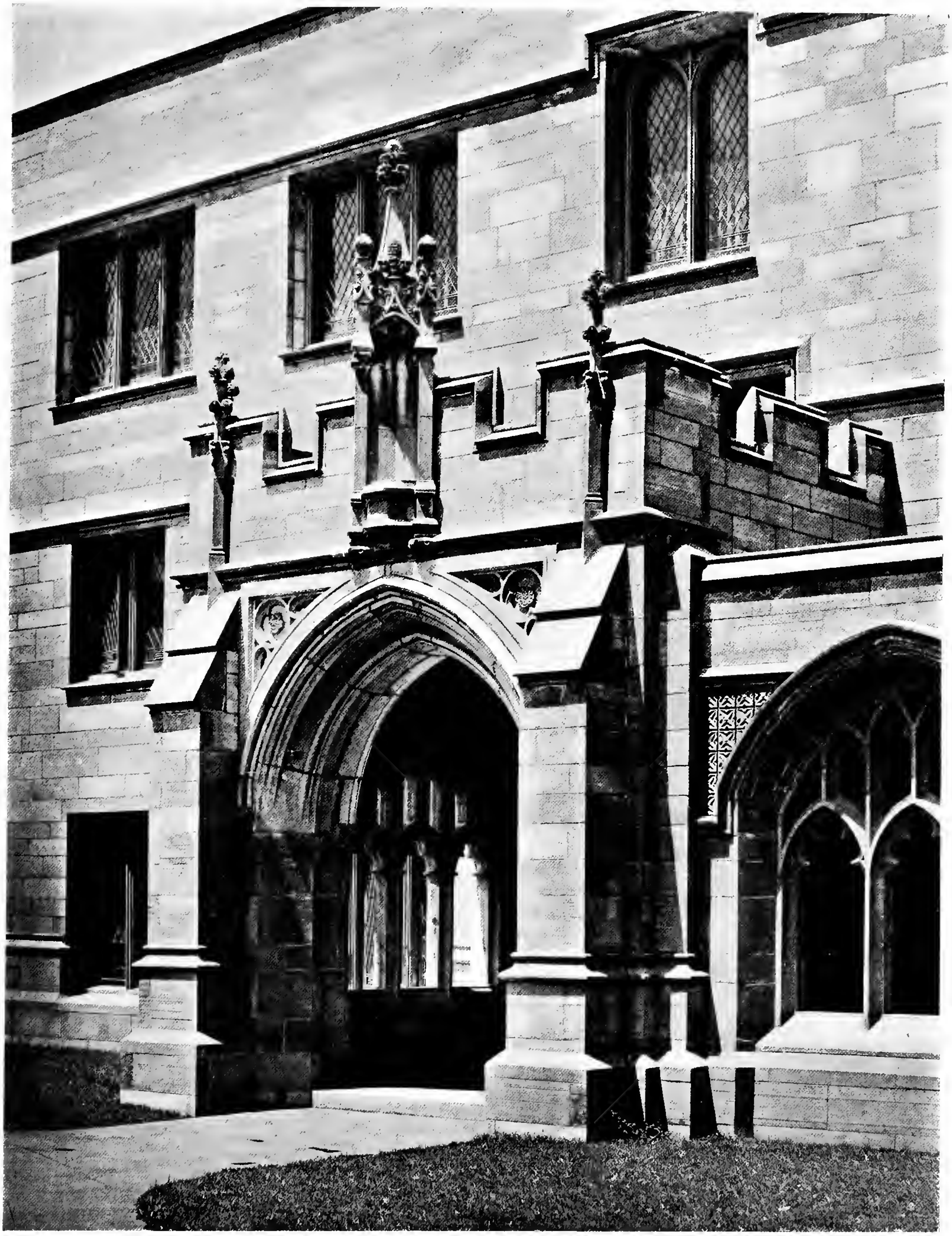
VIEW FROM SOUTHEAST

FIRST PRESBYTERIAN CHURCH, OAKLAND, CAL.

MR. WILLIAM C. HAYS, *ARCHITECT*, SAN FRANCISCO; MESSRS. CRAM, GOODHUE & FERGUSON, *CONSULTING ARCHITECTS*

FIRST PRESBYTERIAN CHURCH, OAKLAND, CAL.

MR. WILLIAM C. HAYS, *ARCHITECT*, SAN FRANCISCO; MESSRS. CRAM, GOODHUE & FERGUSON, *CONSULTING ARCHITECTS*



FIRST PRESBYTERIAN CHURCH, OAKLAND, CAL.

MR. WILLIAM C. HAYS, *ARCHITECT*, SAN FRANCISCO; MESSRS. CRAM, GOODHUE & FERGUSON, *CONSULTING ARCHITECTS*

FIRST PRESBYTERIAN CHURCH, OAKLAND, CAL.

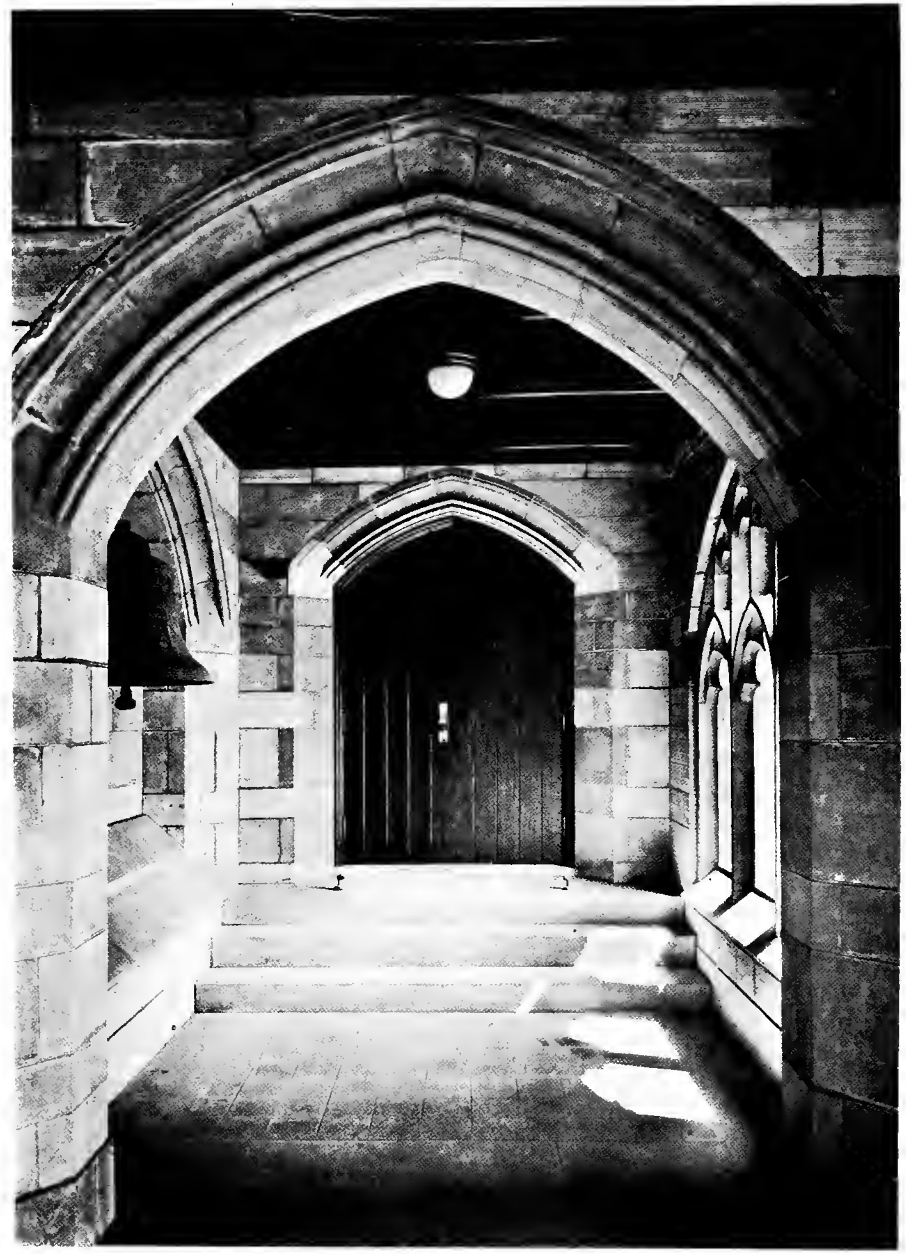
MR. WILLIAM C. HAYS, *ARCHITECT*, SAN FRANCISCO; MESSRS. CRAM, GOODHUE & FERGUSON, *CONSULTING ARCHITECTS*

ASSEMBLY HALL

WOMEN'S MEETING ROOM, FIRST PRESBYTERIAN CHURCH, OAKLAND, CAL.

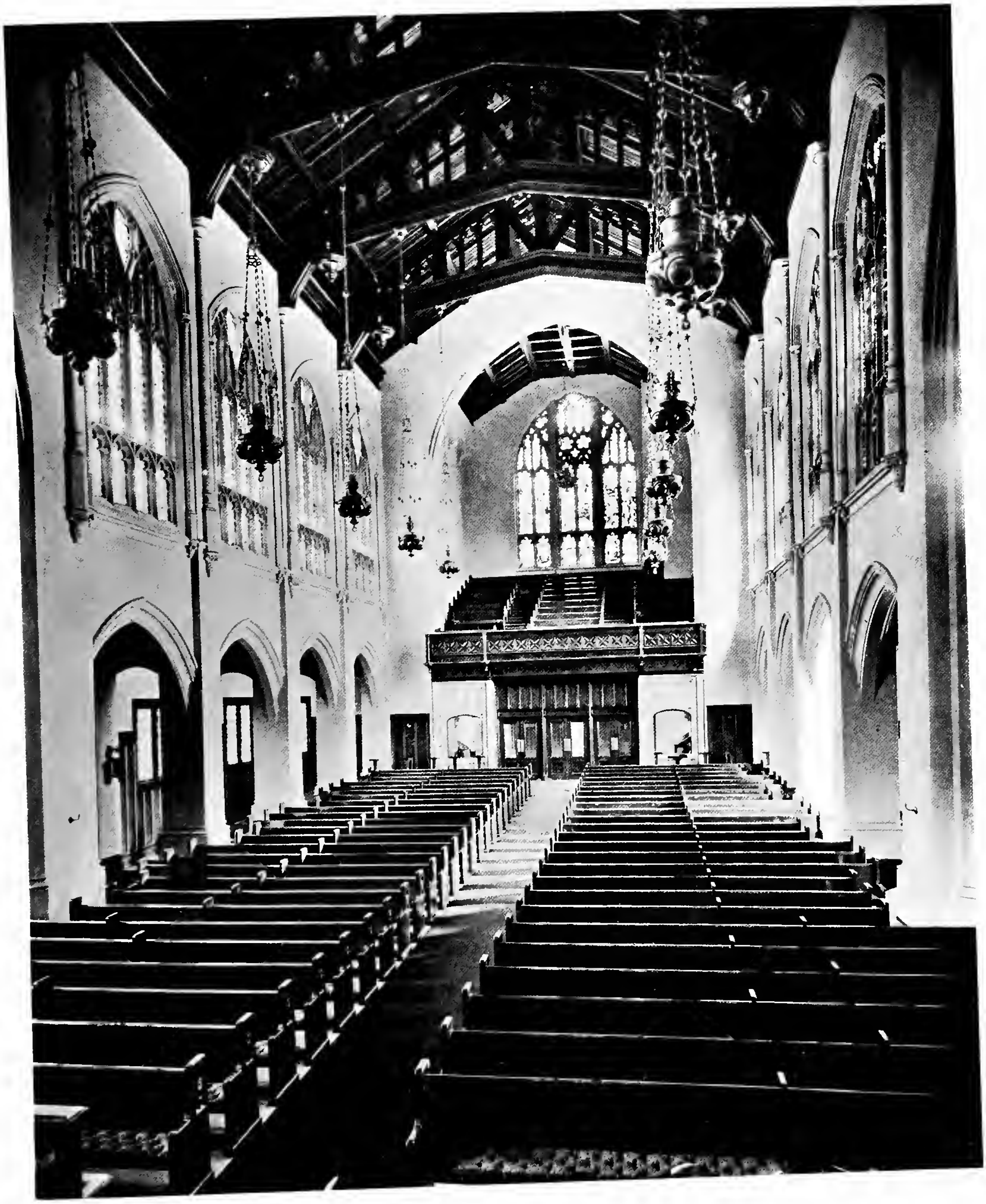
MR. WILLIAM C. HAYS, *ARCHITECT*, SAN FRANCISCO

MESSRS. CRAM, GOODHUE & FERGUSON, *CONSULTING ARCHITECTS*

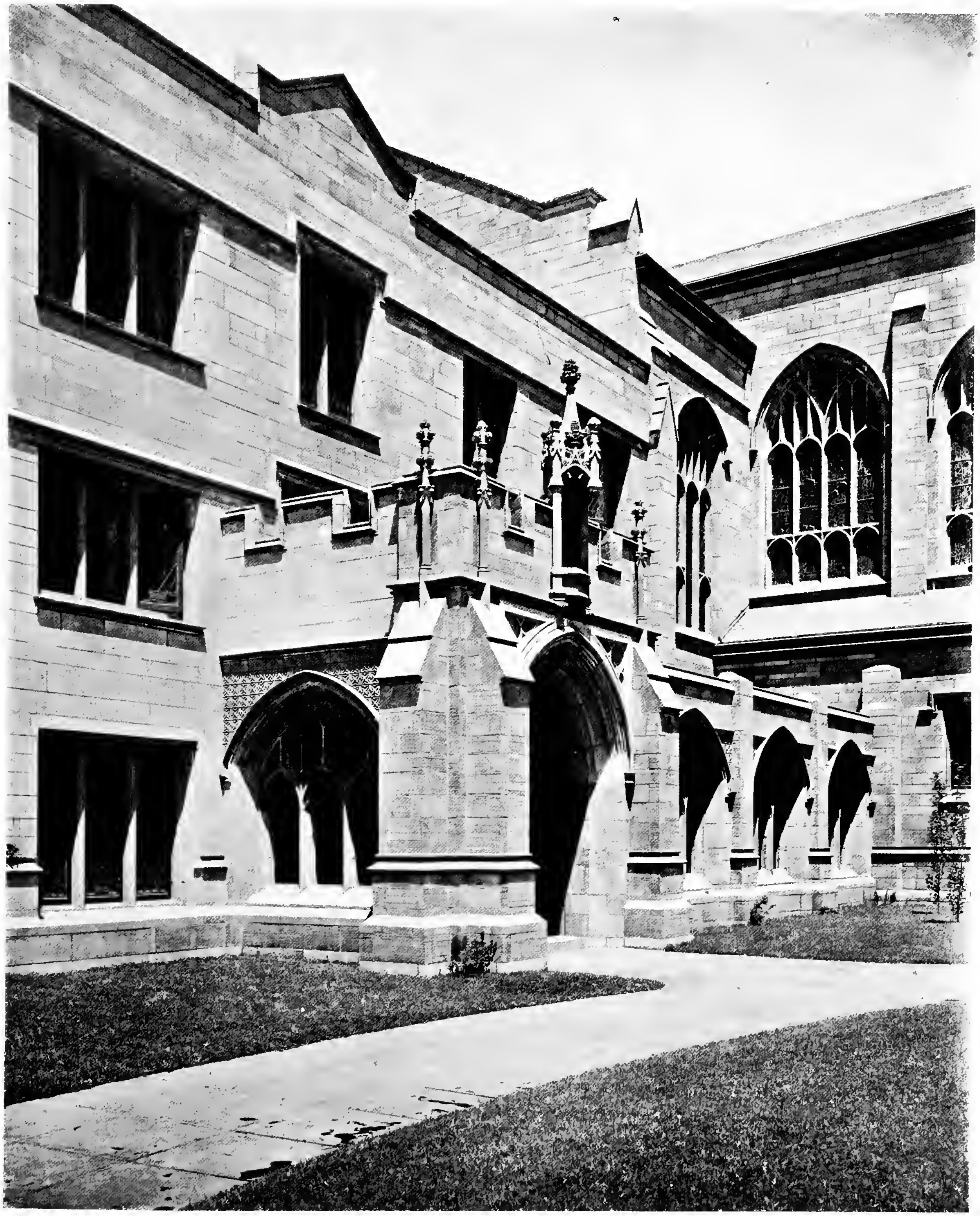


FIRST PRESBYTERIAN CHURCH, OAKLAND, CAL.

MR. WILLIAM C. HAYS, *ARCHITECT*, SAN FRANCISCO; MESSRS. CRAM, GOODHUE & FERGUSON, *CONSULTING ARCHITECTS*

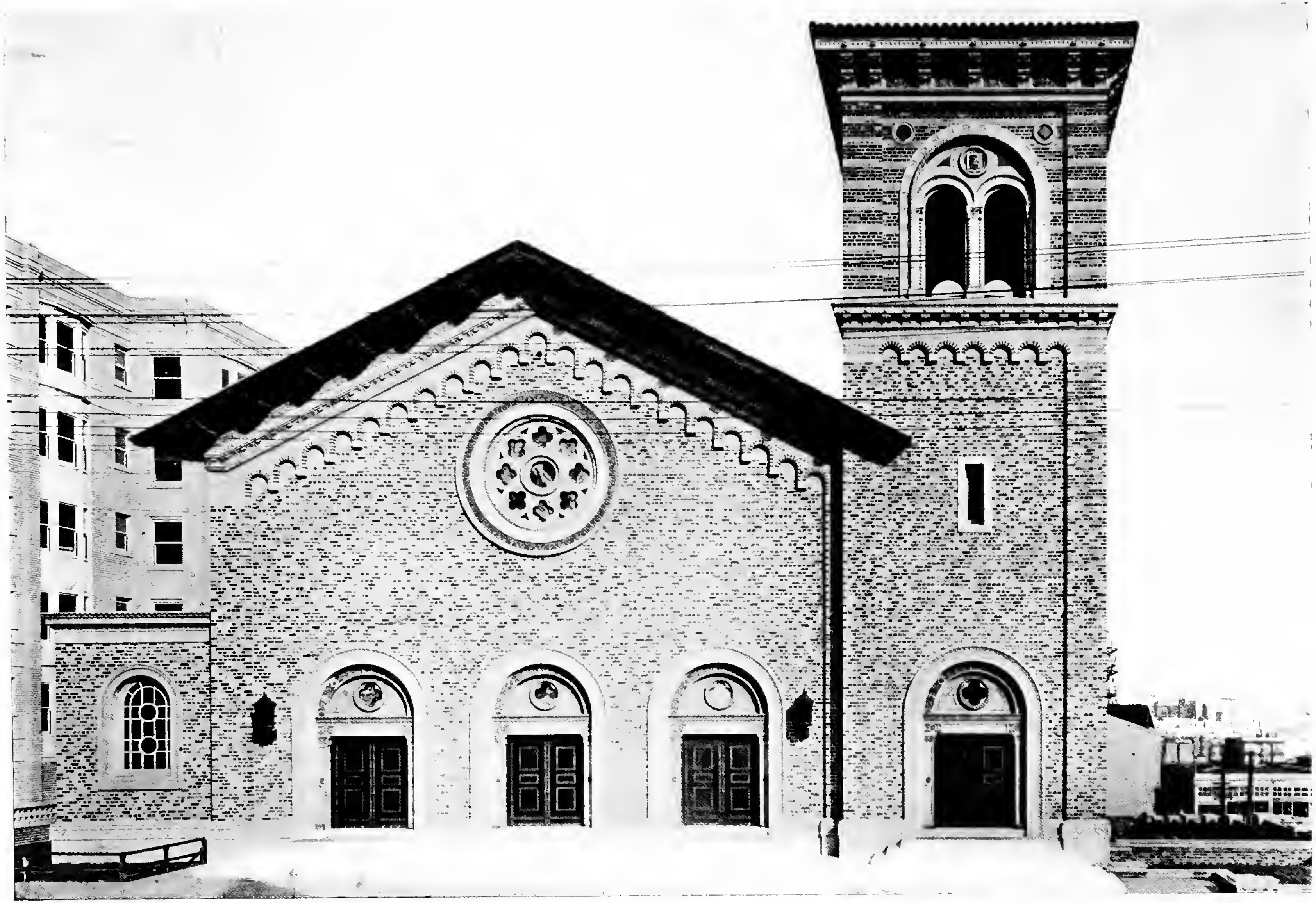


FIRST PRESBYTERIAN CHURCH, OAKLAND, CAL.
MR. WILLIAM C. HAYS, *ARCHITECT*, SAN FRANCISCO; MESSRS. CRAM, GOODHUE & FERGUSON, *CONSULTING ARCHITECTS*

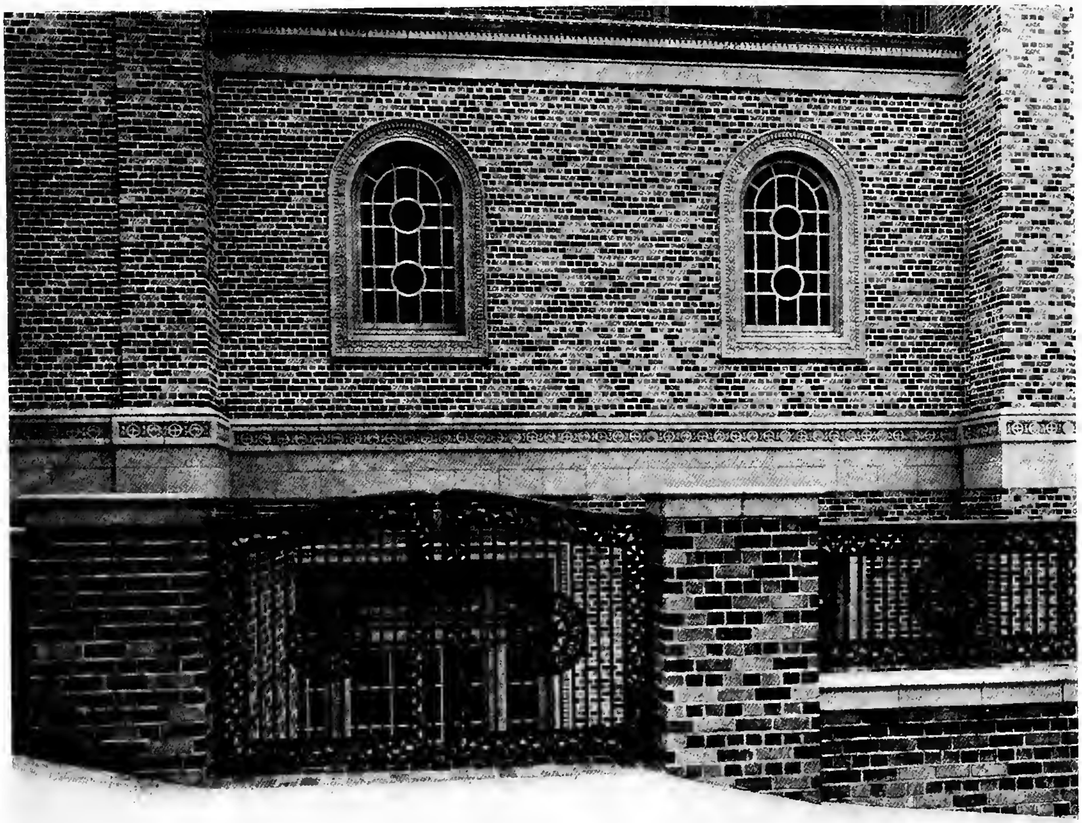


FIRST PRESBYTERIAN CHURCH, OAKLAND, CAL.

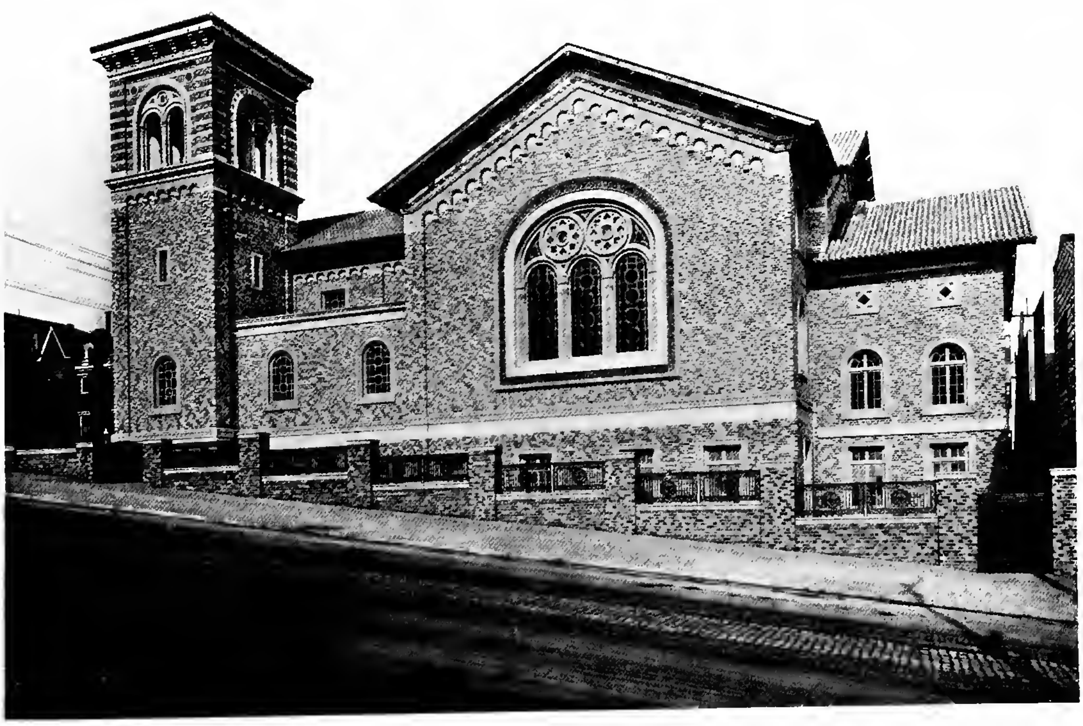
MR. WILLIAM C. HAYS, *ARCHITECT*, SAN FRANCISCO; MESSRS. CRAM, GOODHUE & FERGUSON, *CONSULTING ARCHITECTS*



FIRST CHURCH OF CHRIST SCIENTIST, SAN FRANCISCO, CAL.
MR. EDGAR A. MATHEWS, *ARCHITECT*

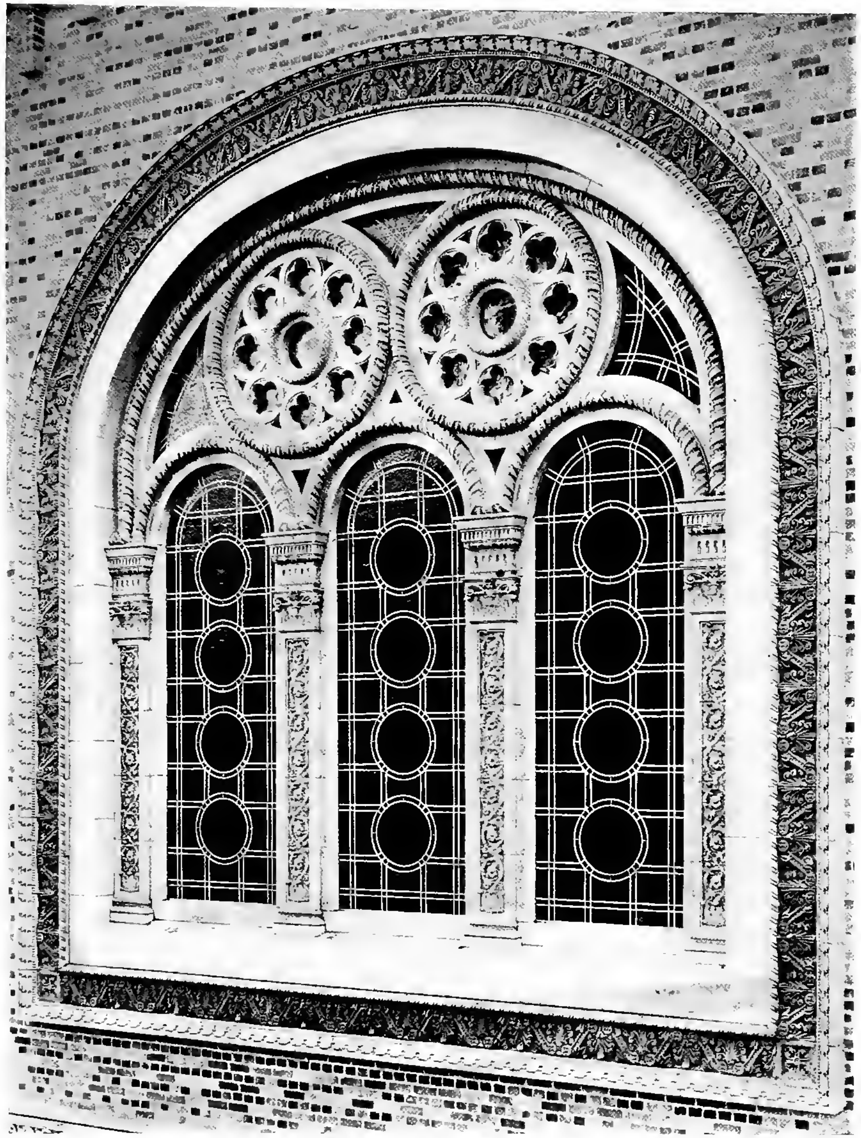


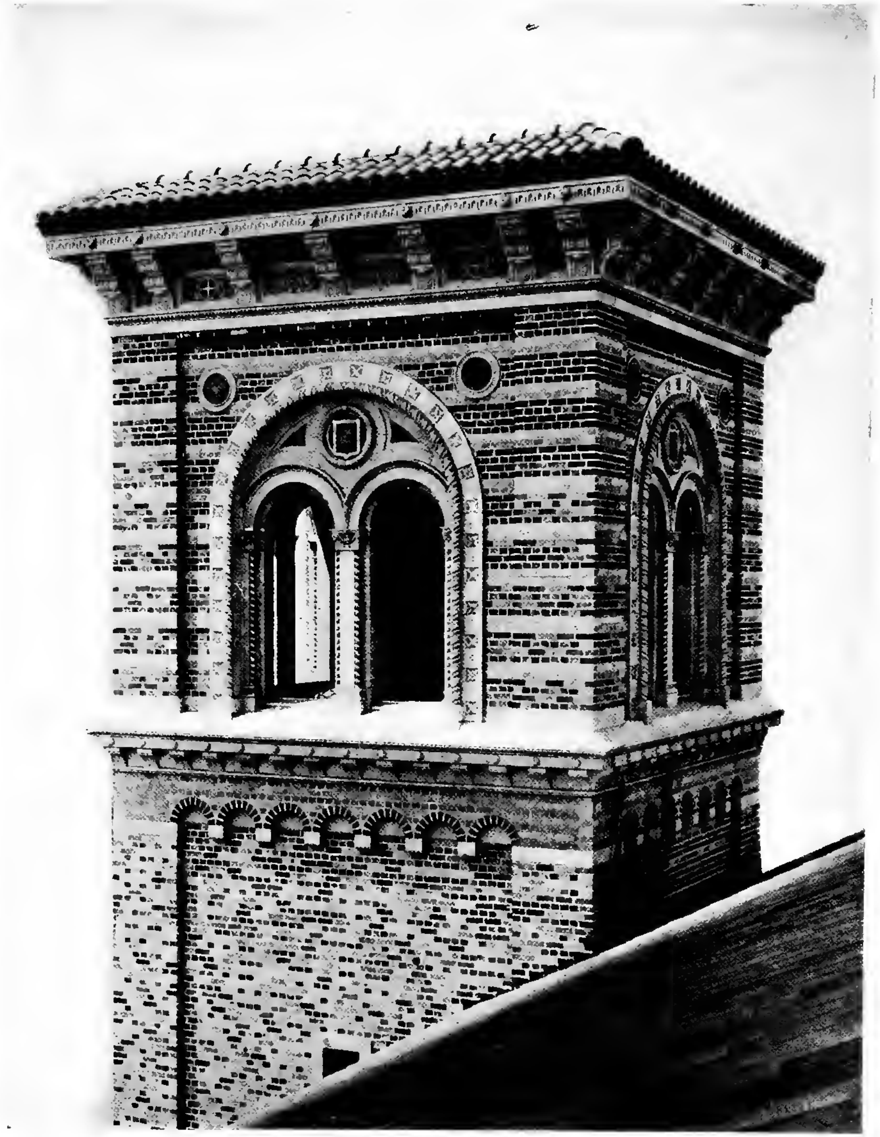
DETAIL OF BRONZE GATES



FIRST CHURCH OF CHRIST SCIENTIST, SAN FRANCISCO, CAL.
MR. EDGAR A. MATHEWS, *ARCHITECT*

FIRST CHURCH OF CHRIST SCIENTIST, SAN FRANCISCO, CAL.
MR. EDGAR A. MATHEWS, *ARCHITECT*





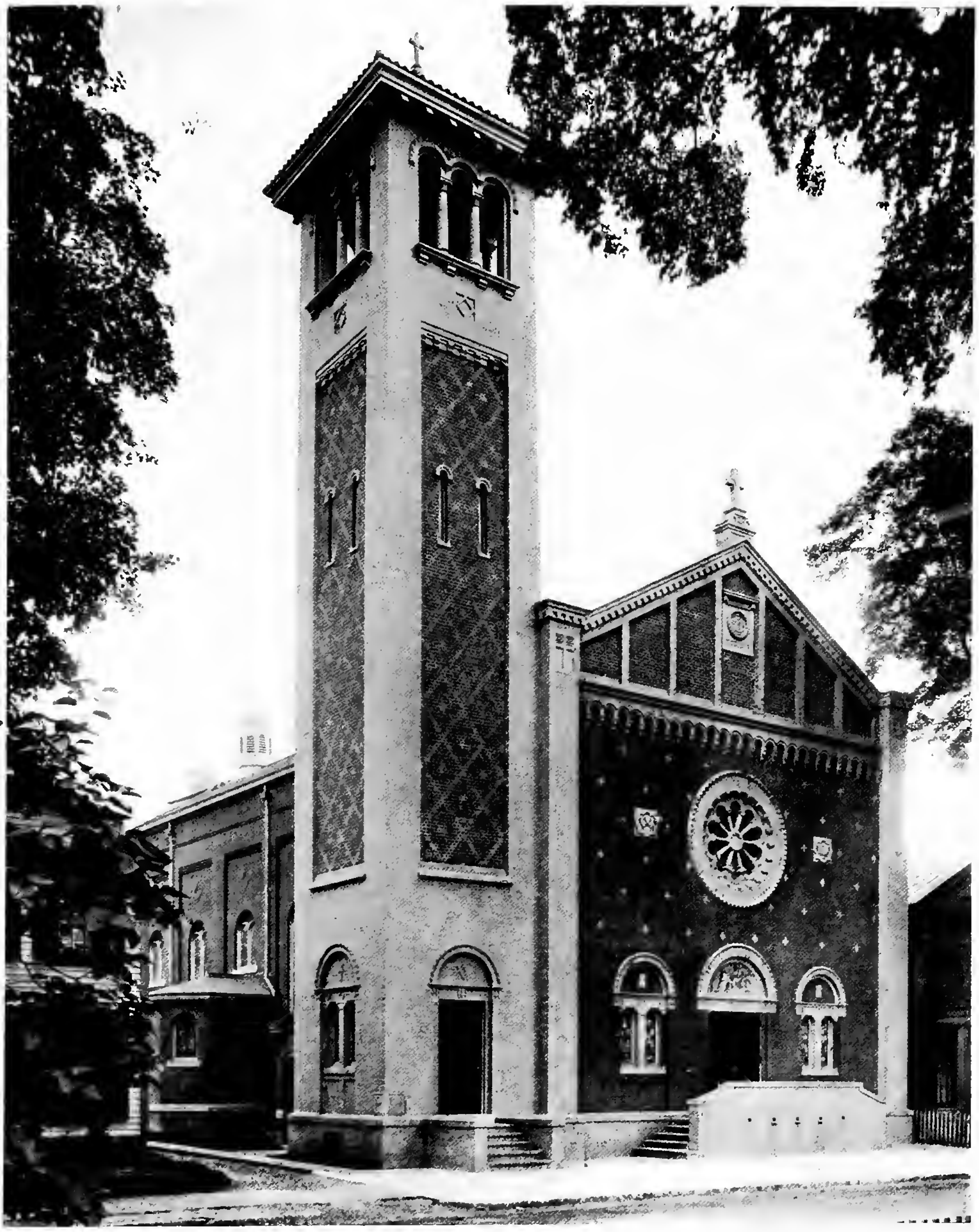
FIRST CHURCH OF CHRIST SCIENTIST, SAN FRANCISCO, CAL.
MR. EDGAR A. MATHEWS, *ARCHITECT*

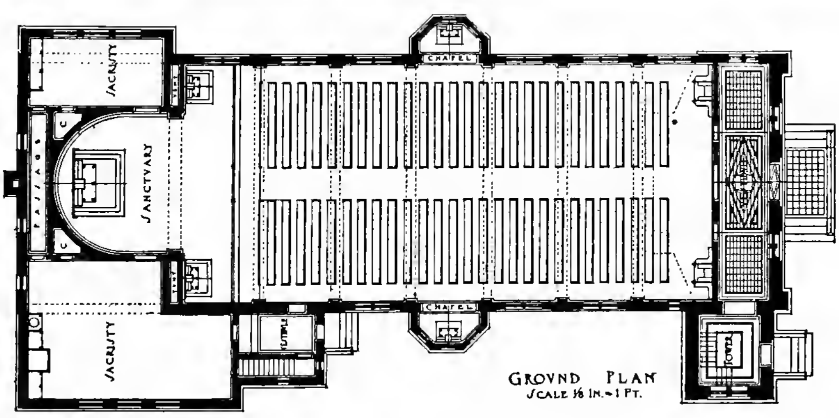
LOOKING TOWARDS ENTRANCE

FIRST CHURCH OF CHRIST SCIENTIST, SAN FRANCISCO, CAL.
MR. EDGAR A. MATHEWS, *ARCHITECT*

FIRST CHURCH OF CHRIST SCIENTIST, SAN FRANCISCO, CAL.

MR. EDGAR A. MATHEWS, *ARCHITECT*





CHURCH OF OUR LADY OF MT. CARMEL, SPRINGFIELD, MASS.

MR. JOHN WILLIAM DONOHOE, *ARCHITECT*

RESTORATION OF THE ASYLUM HILL CONGREGATIONAL CHURCH, HARTFORD, CONN.
MESSRS. ALLEN & COLLENS, *ARCHITECTS*

CHANCEL, CHAPEL OF UNION THEOLOGICAL SEMINARY, NEW YORK
MESSRS. ALLEN & COLLENS, *ARCHITECTS*

THE SKINNER MEMORIAL CHAPEL, HOLYOKE, MASS.
MESSRS. ALLEN & COLLENS, *ARCHITECTS*

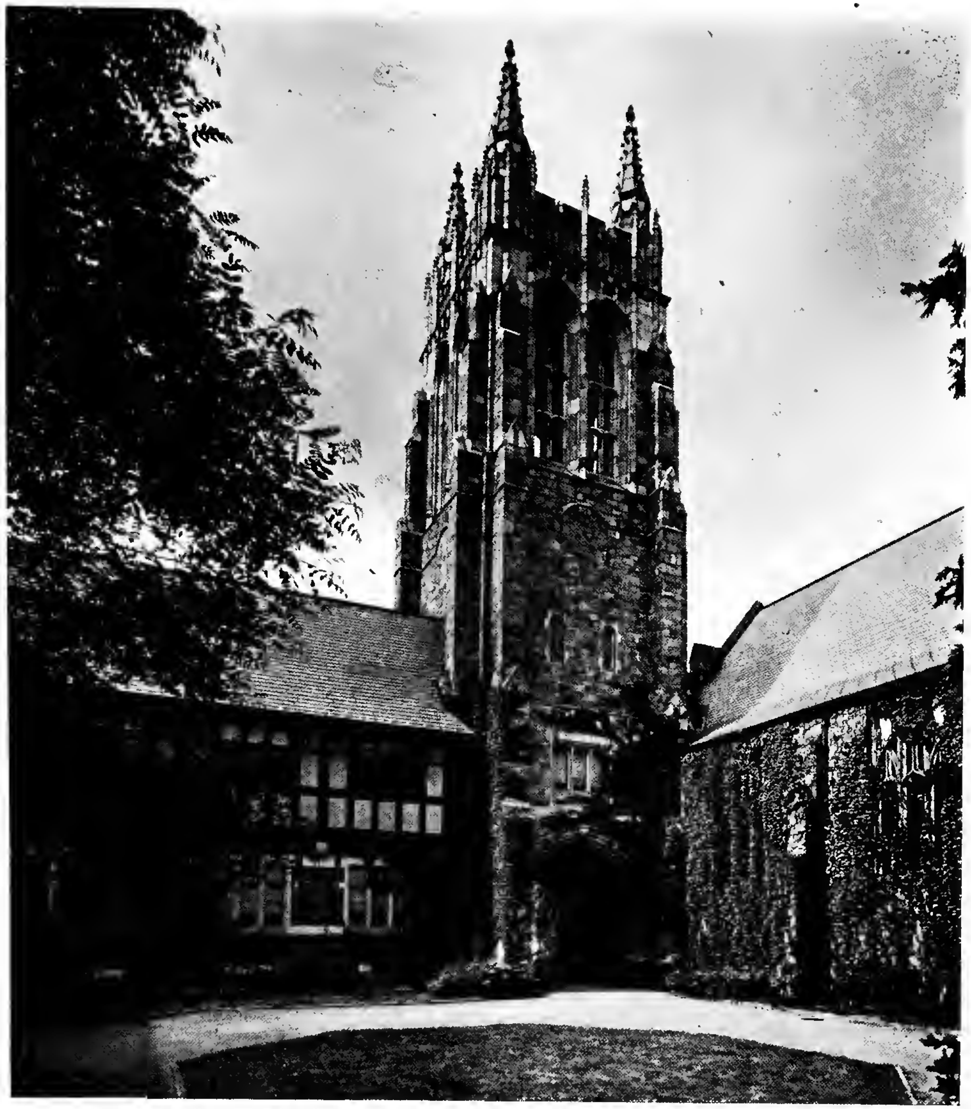
THE CHANCEL

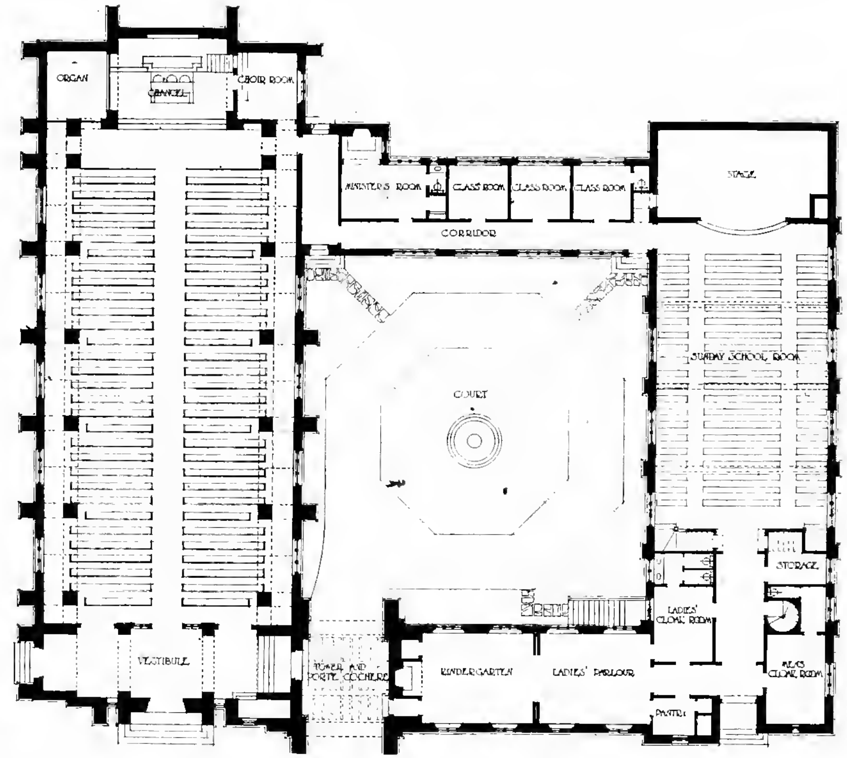
THE SKINNER MEMORIAL CHAPEL, HOLYOKE, MASS.

MESSRS. ALLEN & COLLENS, *ARCHITECTS*

UNITARIAN CHURCH, WEST NEWTON, MASS.
MESSRS. CRAM, GOODHUE & FERGUSON, *ARCHITECTS*

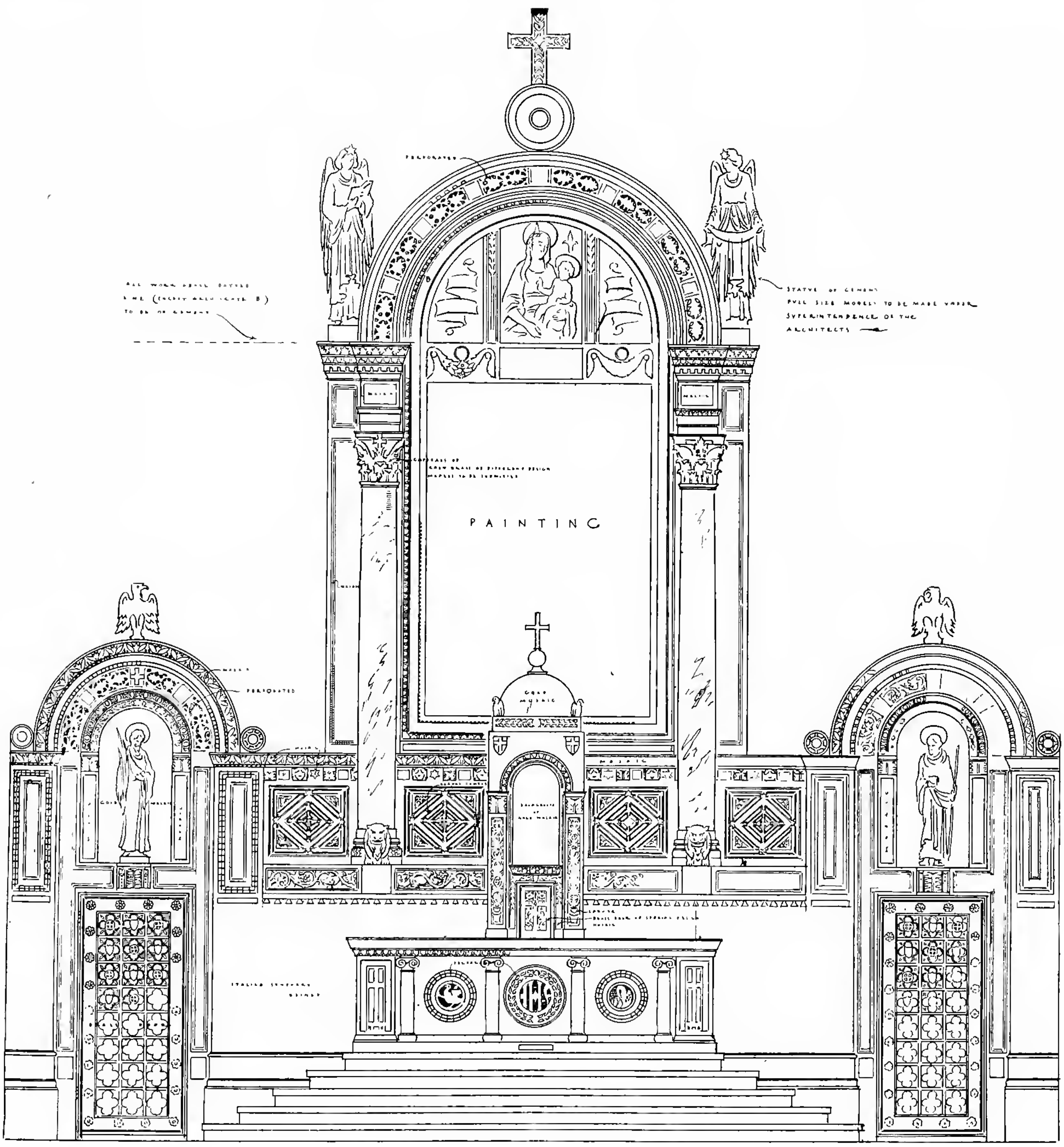
UNITARIAN CHURCH, WEST NEWTON, MASS.
MESSRS. CRAM, GOODHUE & FERGUSON, *ARCHITECTS*





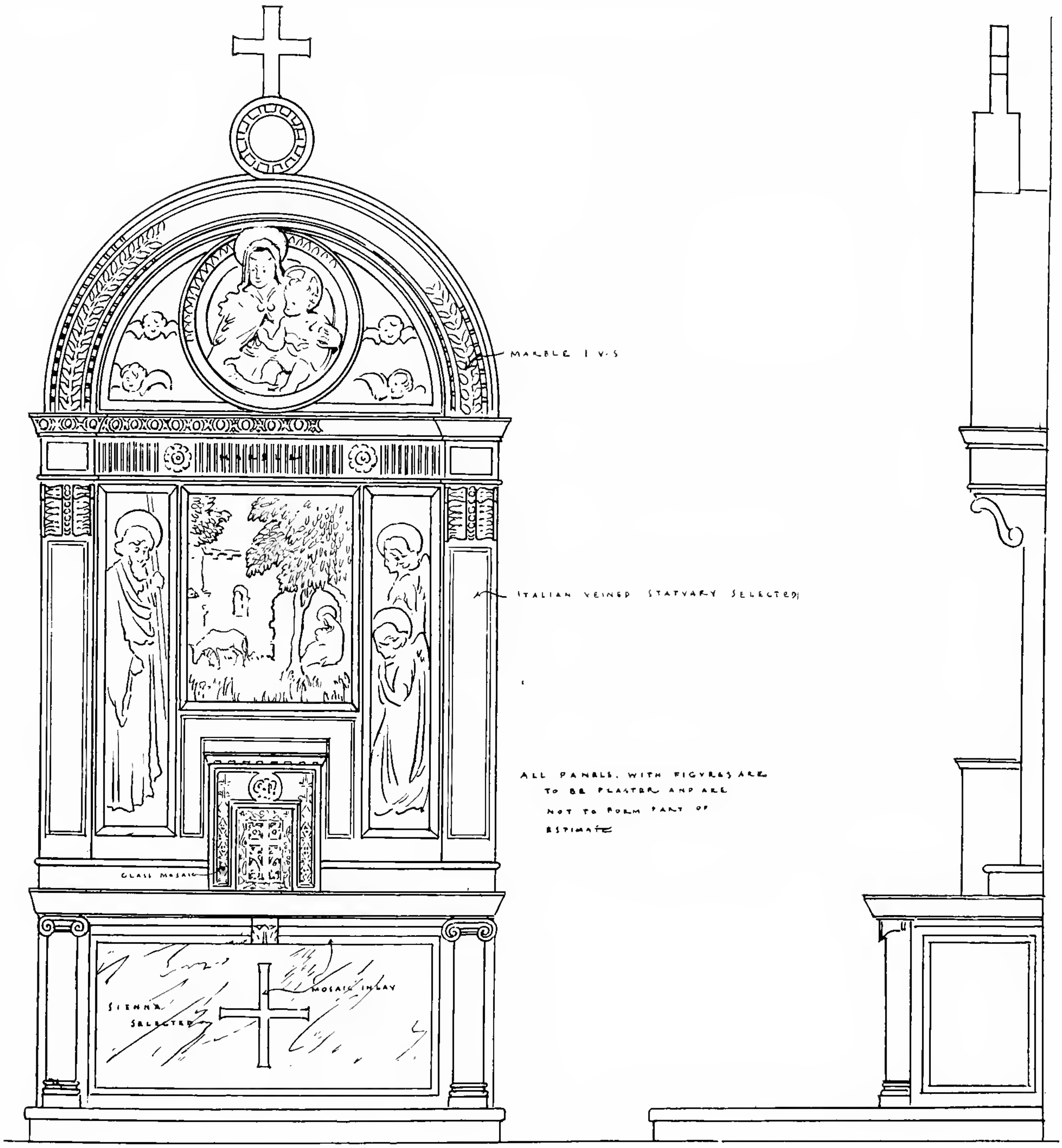
UNITARIAN CHURCH, WEST NEWTON, MASS.

MESSRS. CRAM, GOODHUE & FERGUSON, *ARCHITECTS*

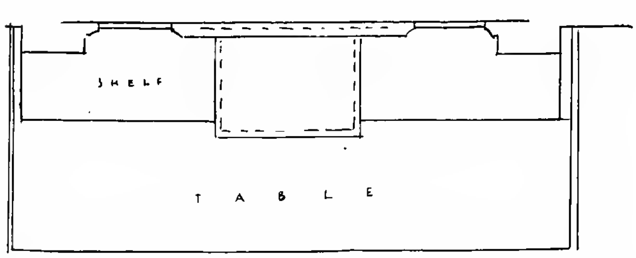


ALTAR AND REREDOS FOR ST. VINCENT'S CHURCH, SOUTH BOSTON, MASS.

MESSRS. MAGINNIS, WALSH & SULLIVAN, *ARCHITECTS*

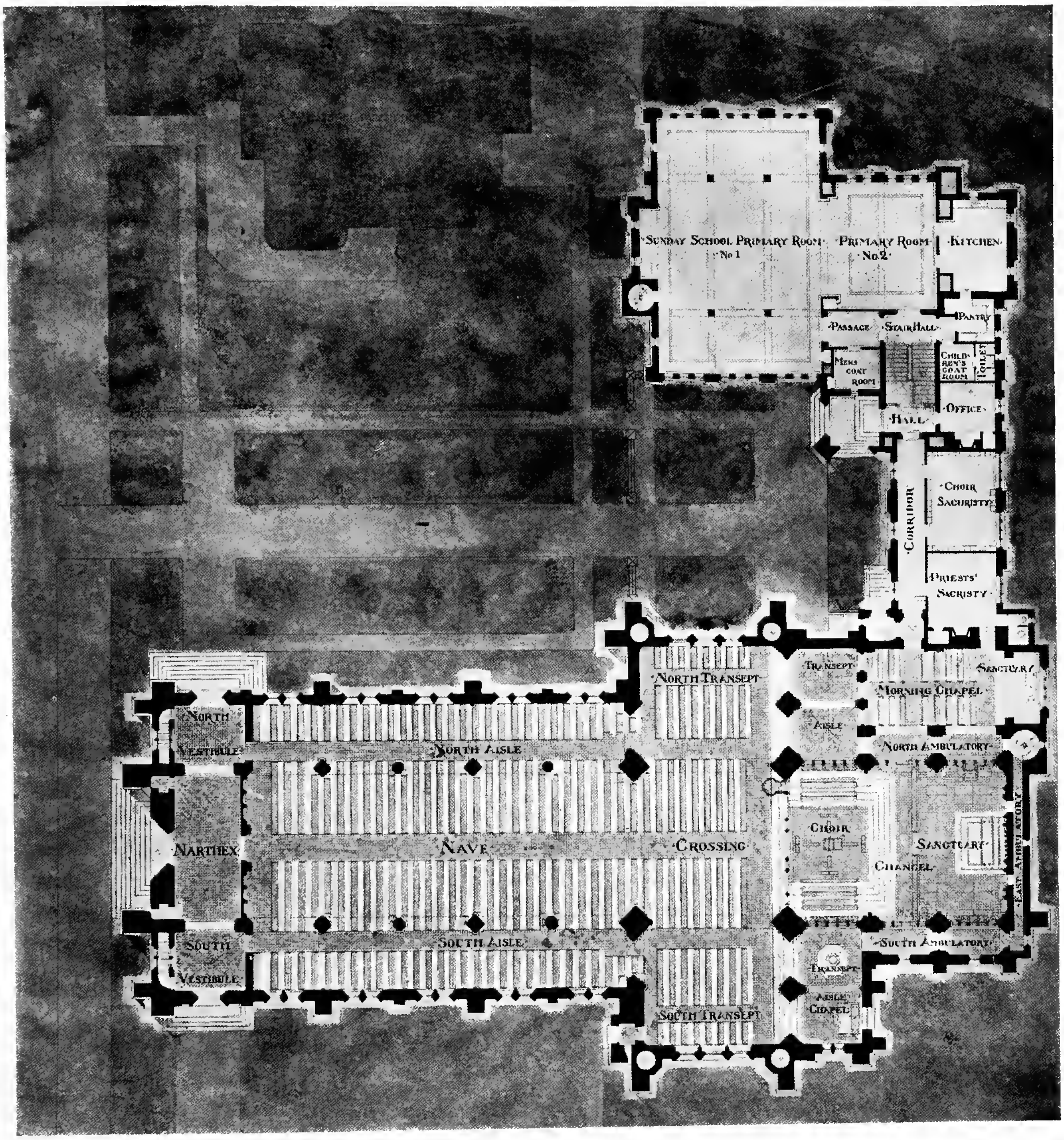


SIDE ALTAR OF MARBLE
SAINT VINCENT'S: SO BOSTON



MESSRS. MAGINNIS, WALSH & SULLIVAN,
ARCHITECTS

CALVARY CHURCH, PITTSBURGH, PA.
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

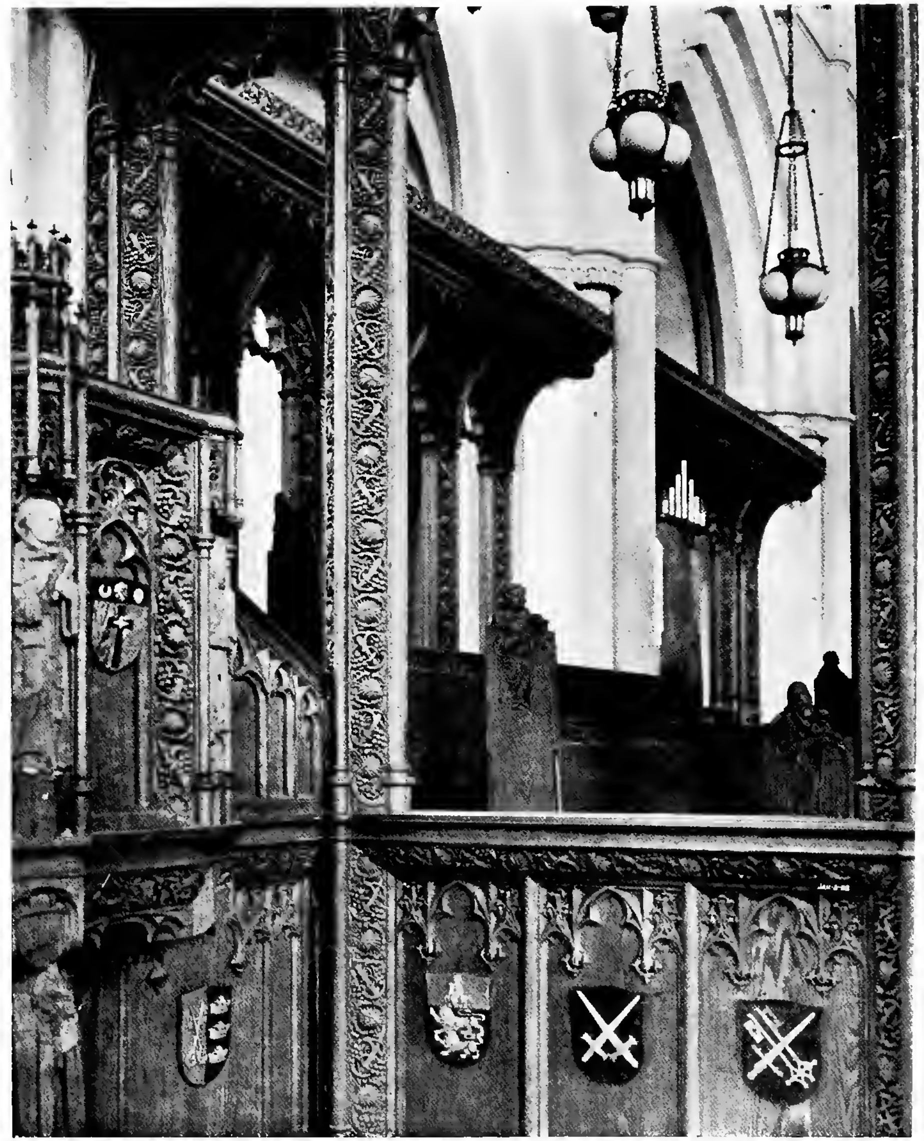


CALVARY CHURCH, PITTSBURGH, PA.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

HIGH ALTAR AND REREDOS, CALVARY CHURCH, PITTSBURGH, PA.
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

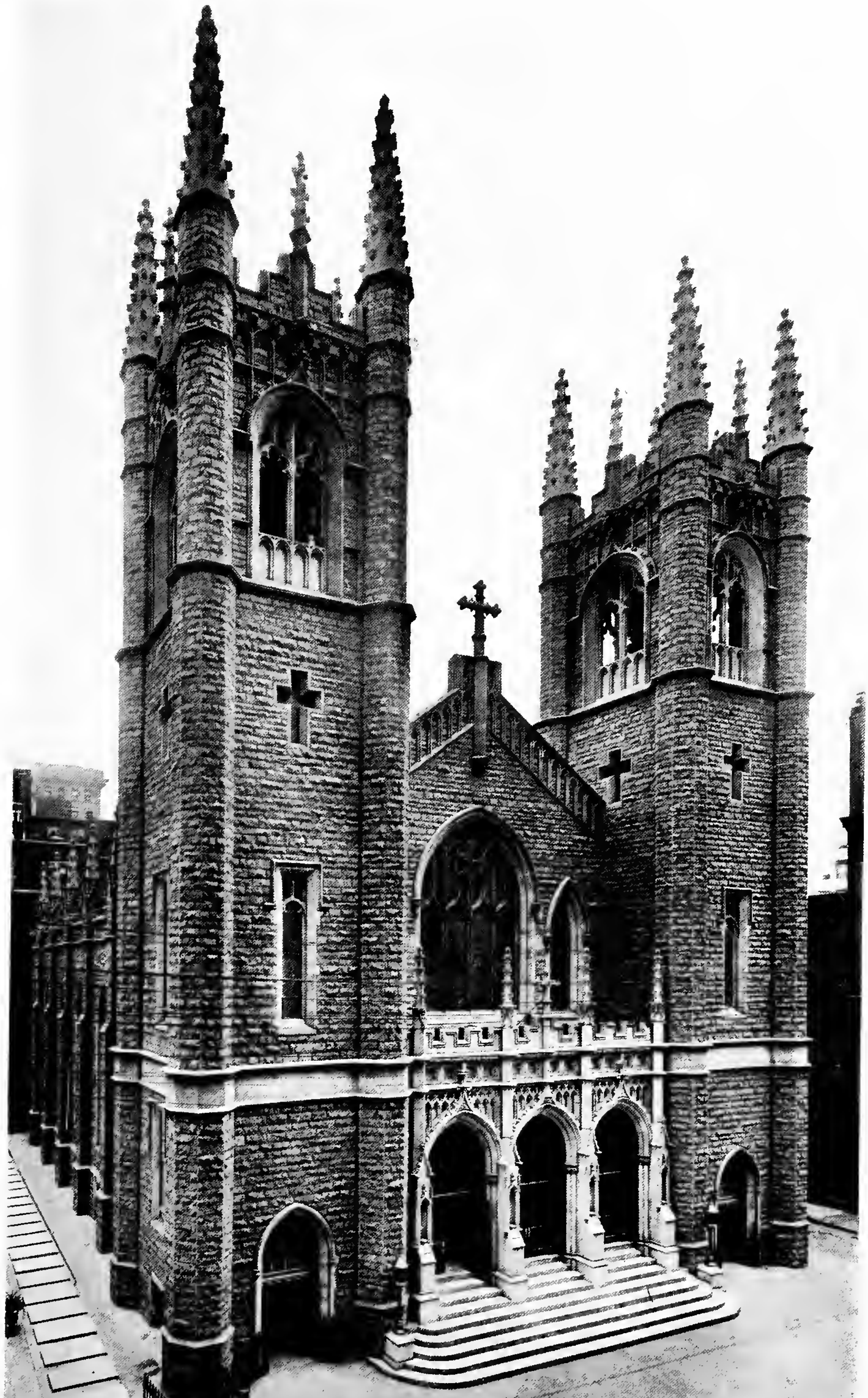
ROOD SCREEN, CALVARY CHURCH, PITTSBURGH, PA.
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



DETAILS OF ROOD SCREEN AND PULPIT

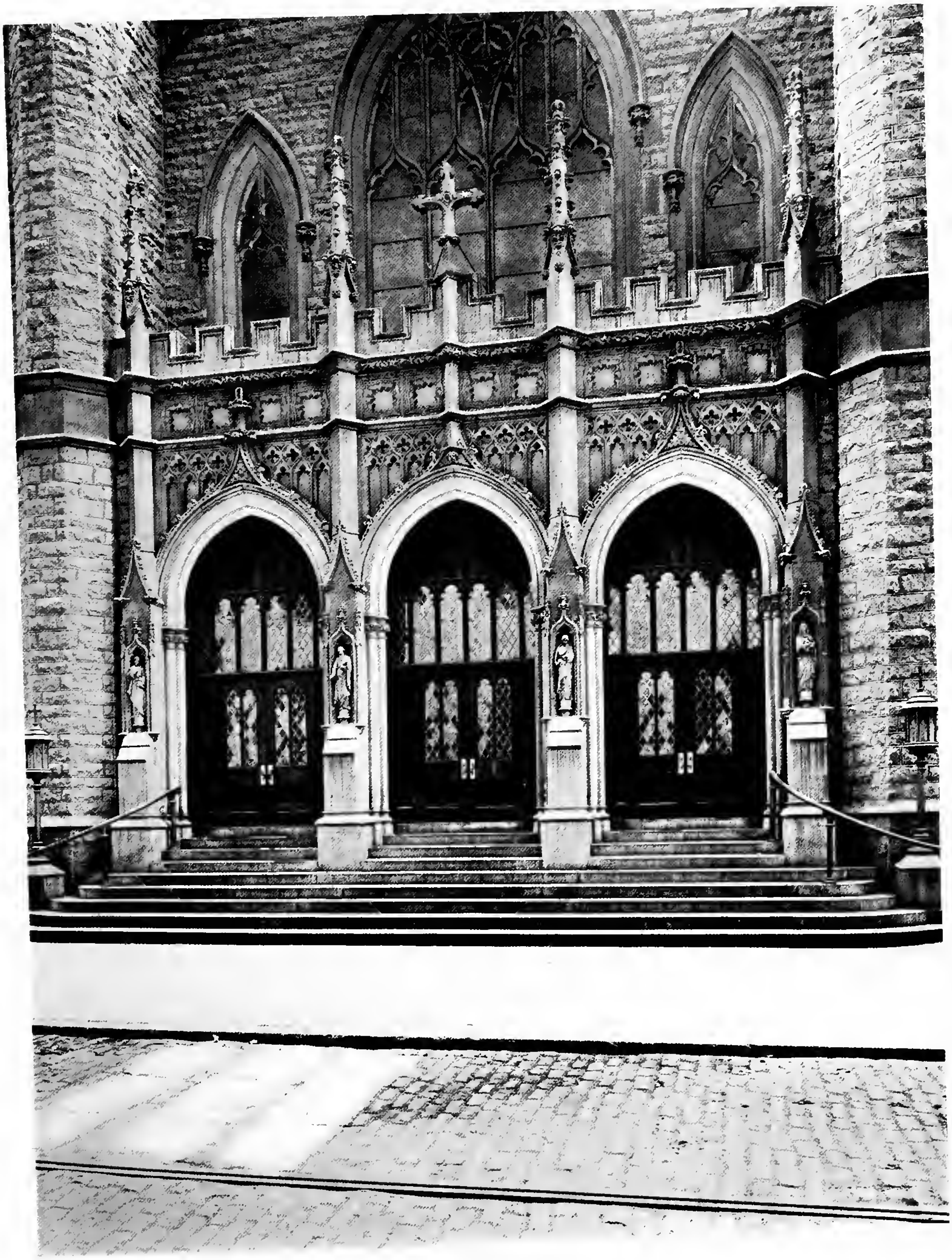
CALVARY CHURCH, PITTSBURGH, PA.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



ST. JOHN'S CHURCH, PHILADELPHIA, PA.

MESSRS. WATSON & HUCKEL, *ARCHITECTS*

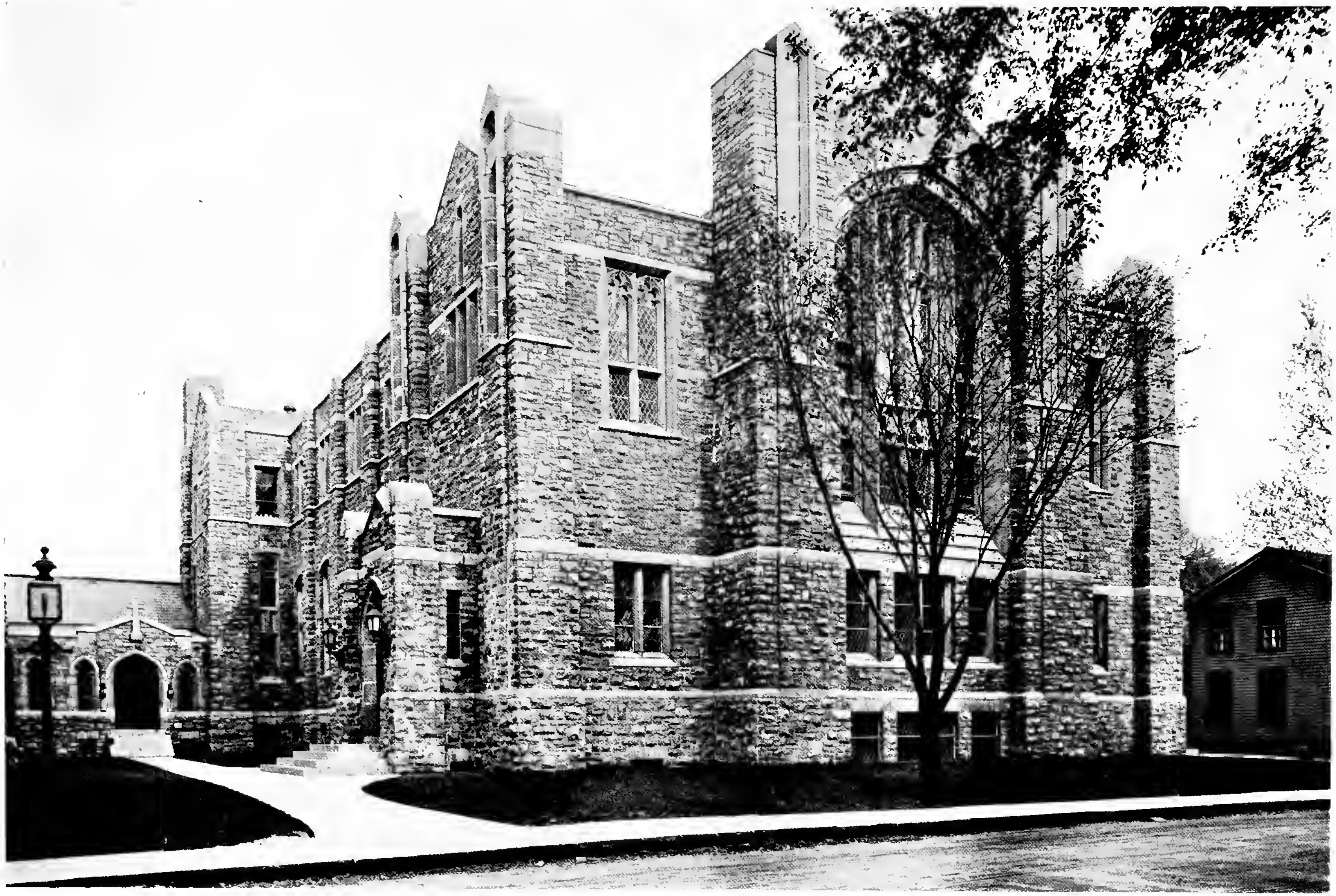


DETAIL OF PRINCIPAL ENTRANCE

ST. JOHN'S CHURCH, PHILADELPHIA, PA.

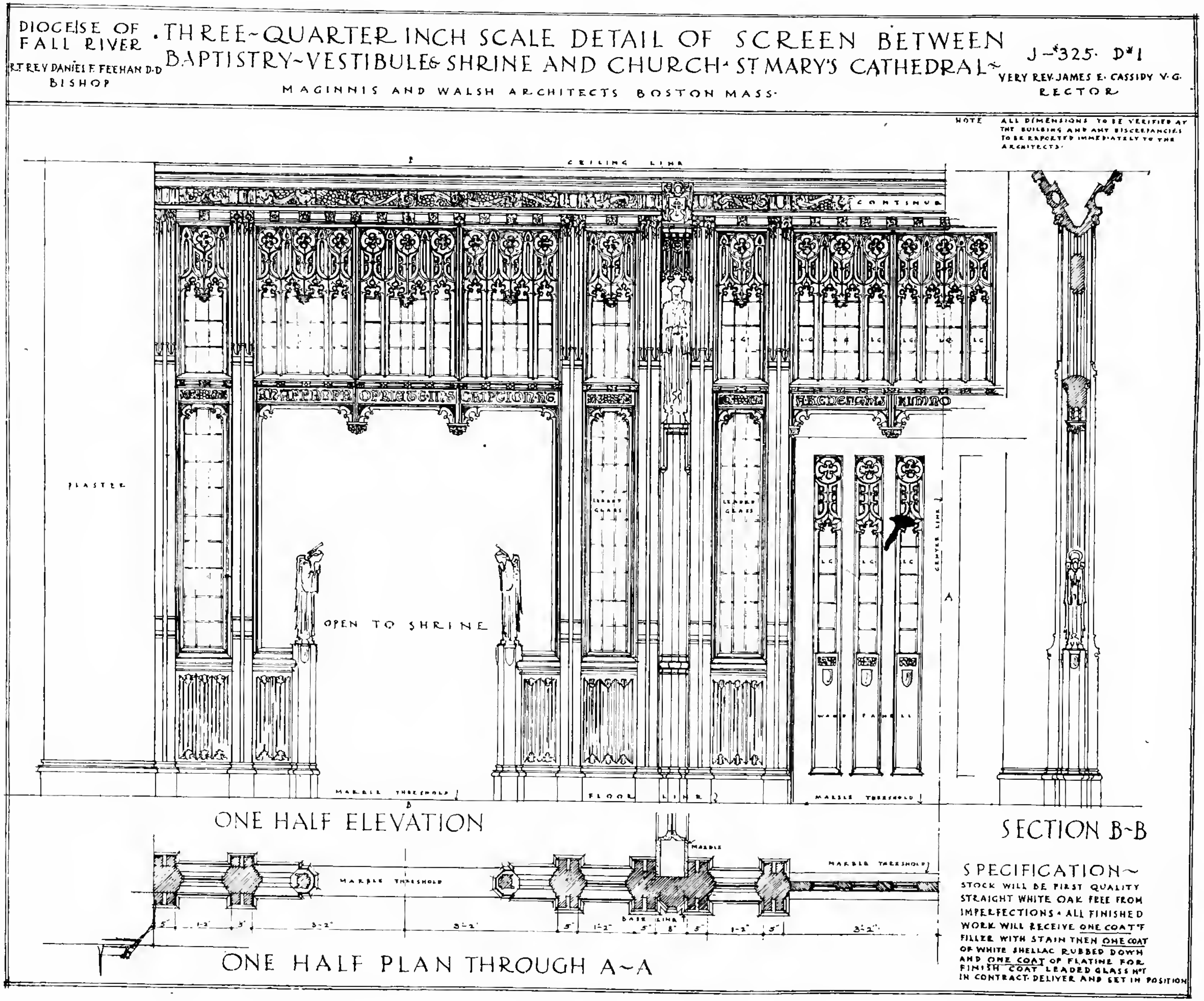
MESSRS. WATSON & HUCKEL, *ARCHITECTS*

CHURCH OF THE EPIPHANY, PHILADELPHIA, PA.
MESSRS. WATSON & HUCKEL, *ARCHITECTS*

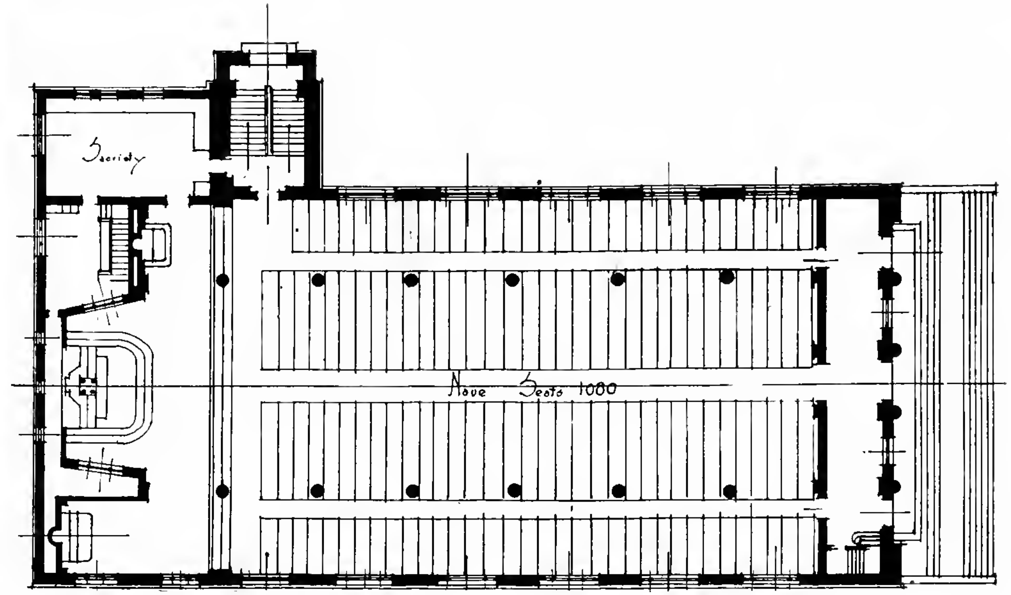


PARISH HOUSE FOR TRINITY PARISH, WATERTOWN, N. Y.

MESSRS. WATSON & HUCKEL, *ARCHITECTS*

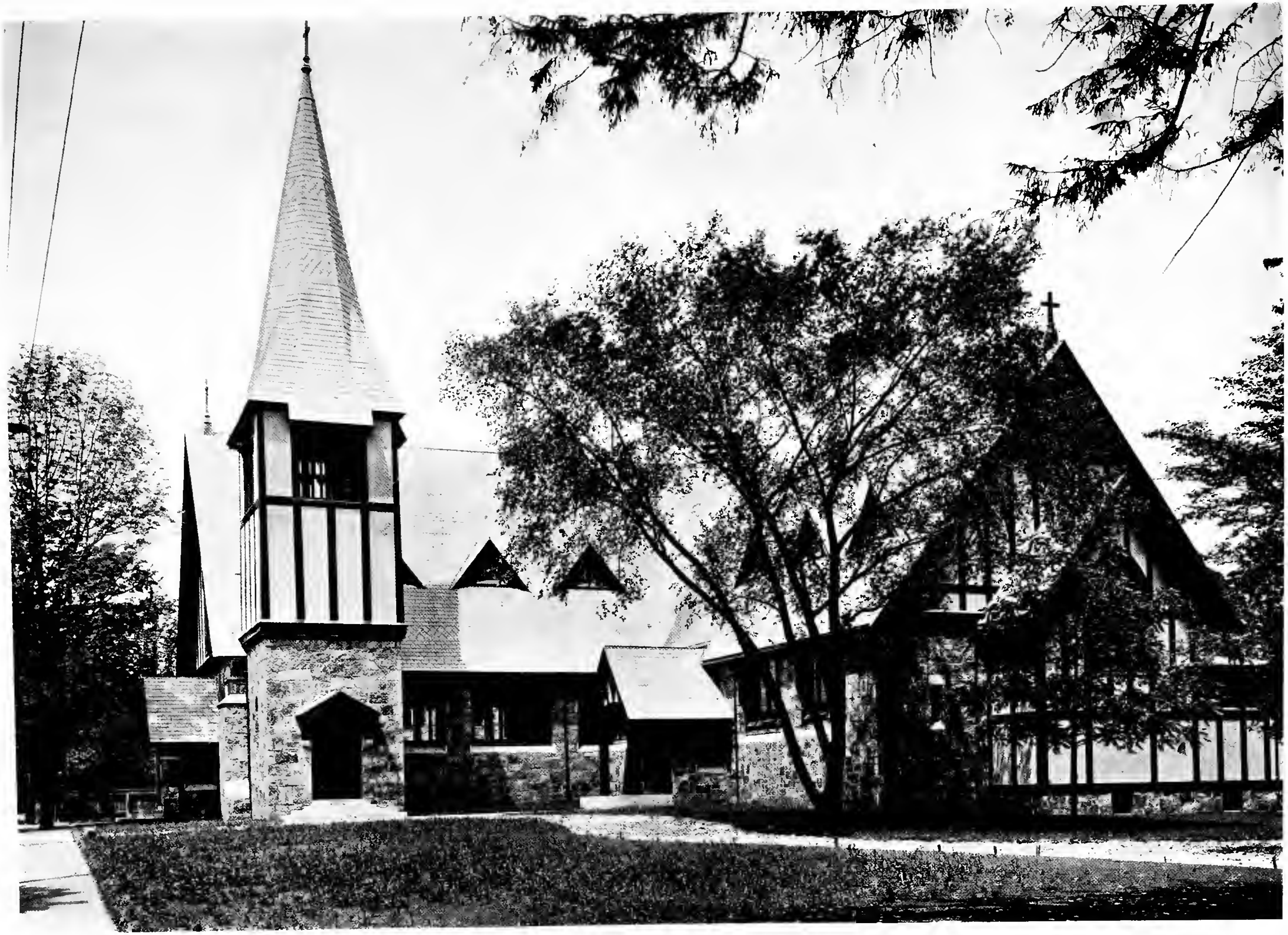

DIOCESE OF FALL RIVER
RT REV DANIEL F. FEEHAN D.D BISHOP
THREE-QUARTER INCH SCALE DETAIL OF SCREEN BETWEEN BAPTISTRY-VESTIBULE & SHRINE AND CHURCH · ST MARY'S CATHEDRAL
J-#325 · D#1
VERY REV. JAMES E. CASSIDY V.G. RECTOR
MAGINNIS AND WALSH ARCHITECTS BOSTON MASS.
NOTE ALL DIMENSIONS TO BE VERIFIED AT THE BUILDING AND ANY DISCREPANCIES TO BE REPORTED IMMEDIATELY TO THE ARCHITECTS.
CEILING LINE
CONTINUE
PLASTER
OPEN TO SHRINE
LEADED GLASS
CENTER LINE
MARBLE THRESHOLD
FLOOR LINE
ONE HALF ELEVATION
SECTION B-B
MARBLE
BASE LINE
ONE HALF PLAN THROUGH A-A
SPECIFICATION~
STOCK WILL BE FIRST QUALITY STRAIGHT WHITE OAK FREE FROM IMPERFECTIONS · ALL FINISHED WORK WILL RECEIVE ONE COAT OF FILLER WITH STAIN THEN ONE COAT OF WHITE SHELLAC RUBBED DOWN AND ONE COAT OF FLATINE FOR FINISH COAT · LEADED GLASS NOT IN CONTRACT · DELIVER AND SET IN POSITION

ST. JOHN'S CHURCH, NORTH CAMBRIDGE, MASS.
MESSRS. MAGINNIS, WALSH & SULLIVAN, *ARCHITECTS*

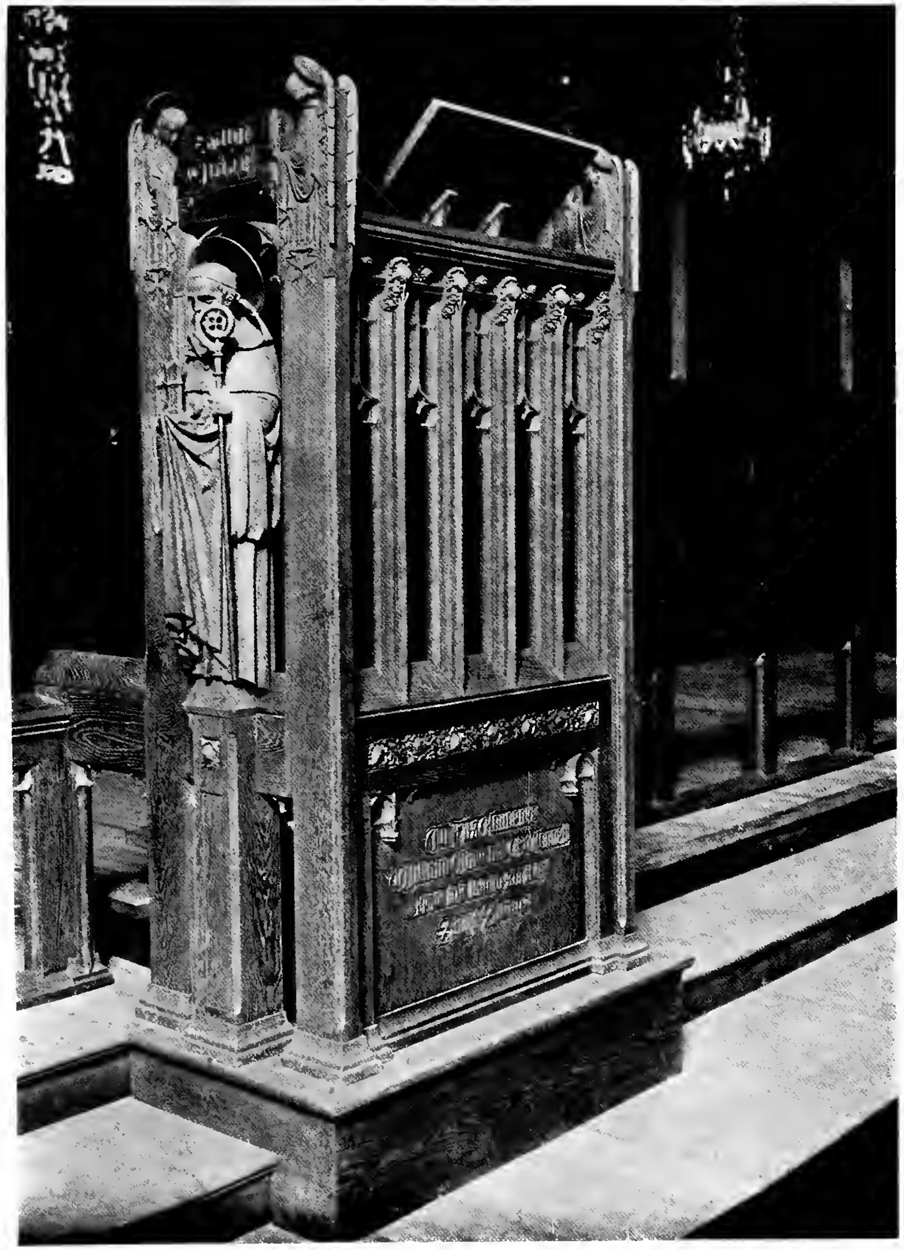


ST. JOHN'S CHURCH,
NORTH CAMBRIDGE, MASS.

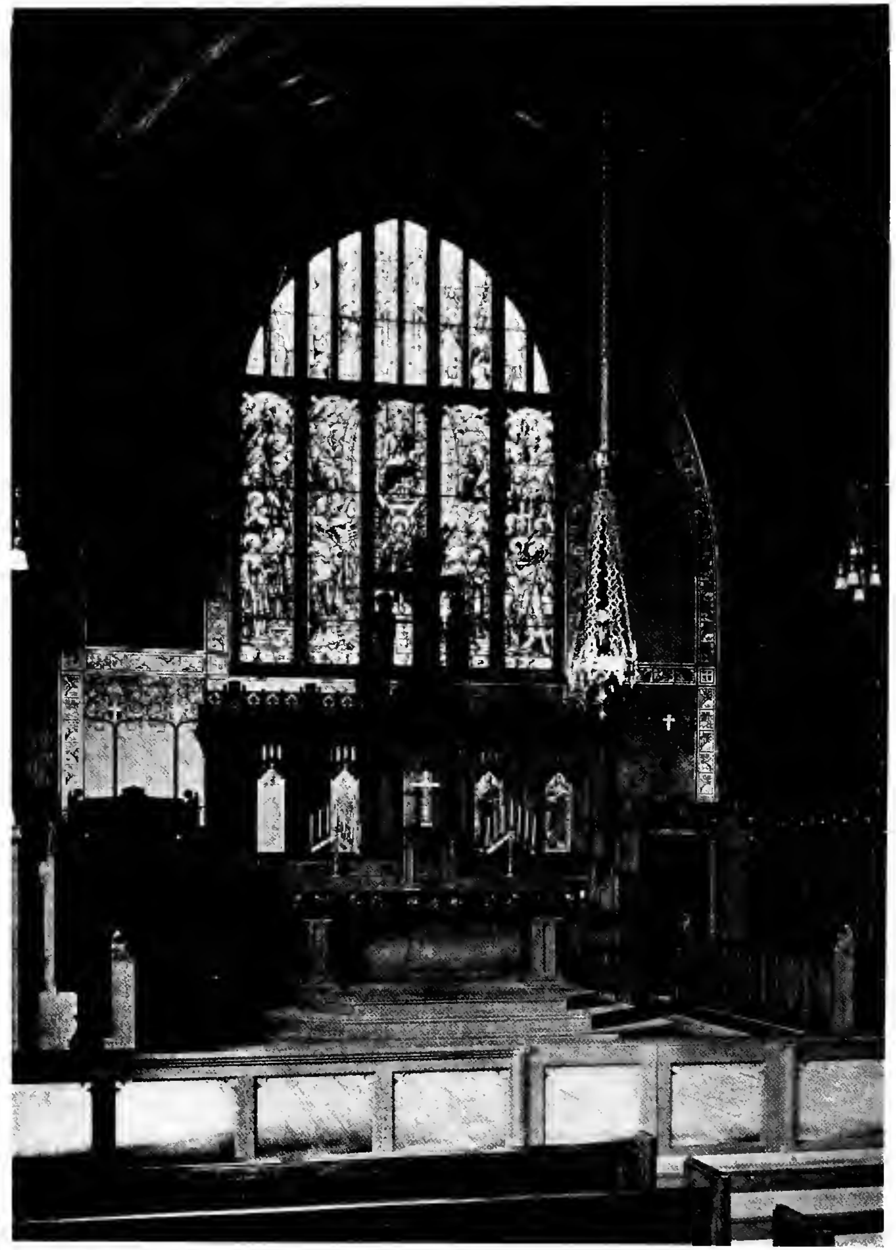
MESSRS. MAGINNIS, WALSH & SULLIVAN, *ARCHITECTS*



ST. AIDAN'S CHURCH, BROOKLINE, MASS.
MESSRS. MAGINNIS & WALSH, *ARCHITECTS*



PULPIT



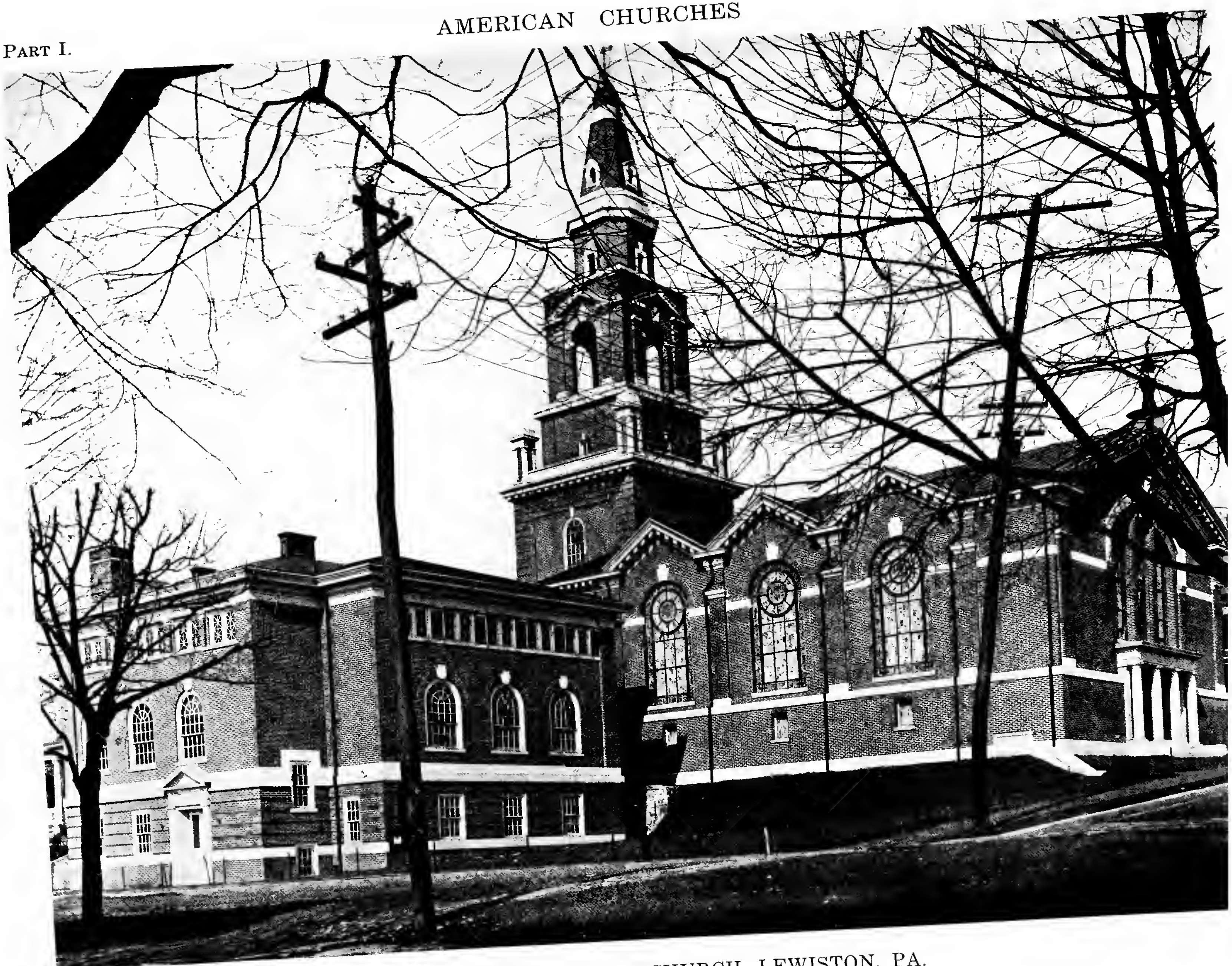
CHANCEL

ST. AIDAN'S CHURCH, BROOKLINE, MASS.

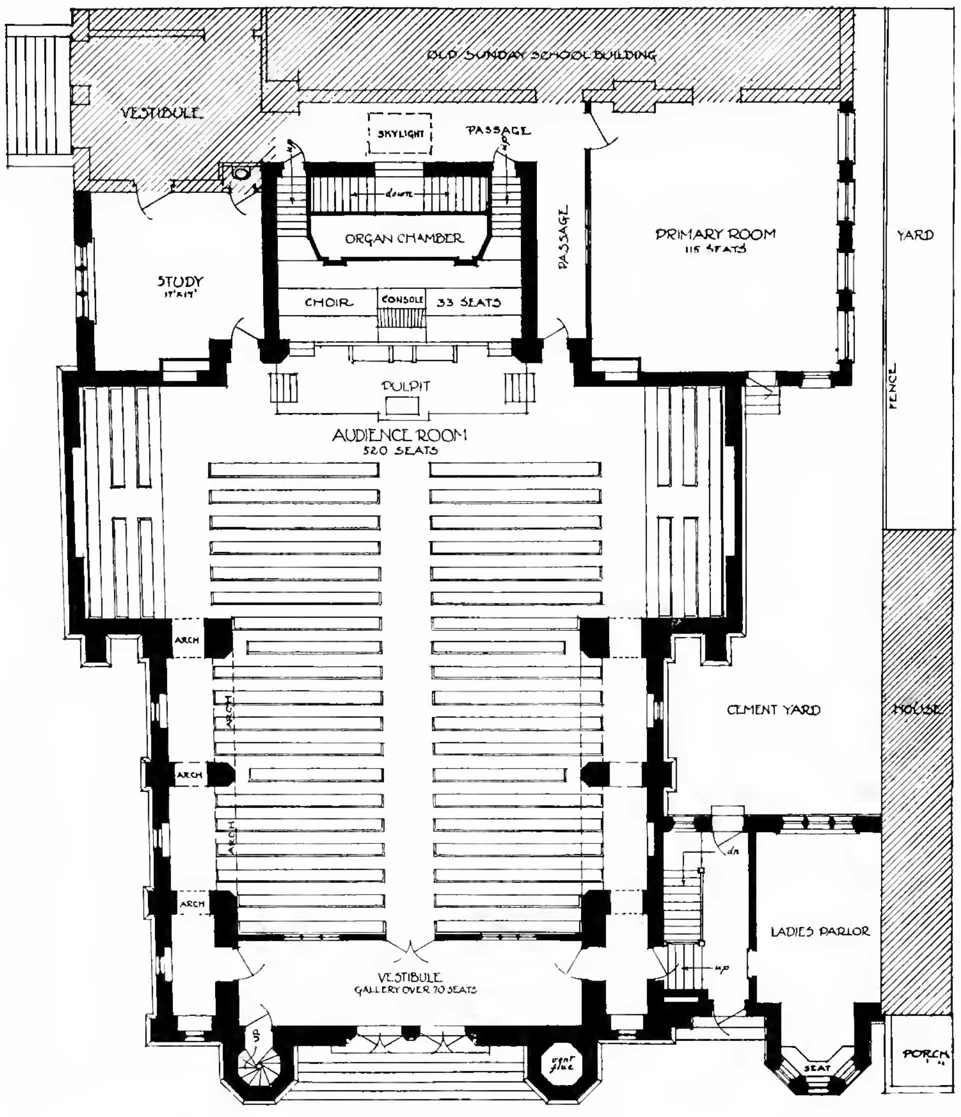
MESSRS. MAGINNIS & WALSH, *ARCHITECTS*

EMMANUEL PRESBYTERIAN CHURCH, PHILADELPHIA, PA.

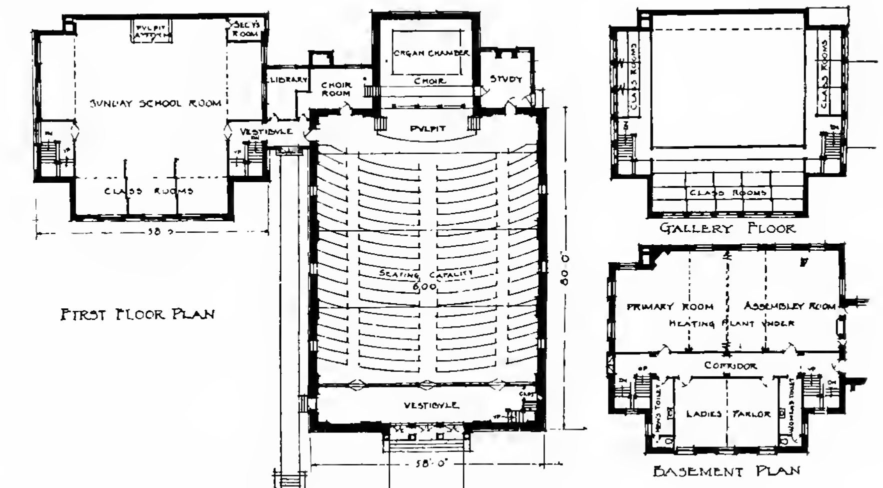
MESSRS. C. W. BOLTON & SON, *ARCHITECTS*



FIRST PRESBYTERIAN CHURCH, LEWISTON, PA.
MESSRS. C. W. BOLTON & SON, *ARCHITECTS*



FIRST FLOOR PLAN
THE EMMANUEL PRESBYTERIAN CHURCH



FIRST PRESBYTERIAN CHURCH,
LEWISTOWN, PA.

PLANS OF

FIRST PRESBYTERIAN CHURCH,
LEWISTON, PA.

AND

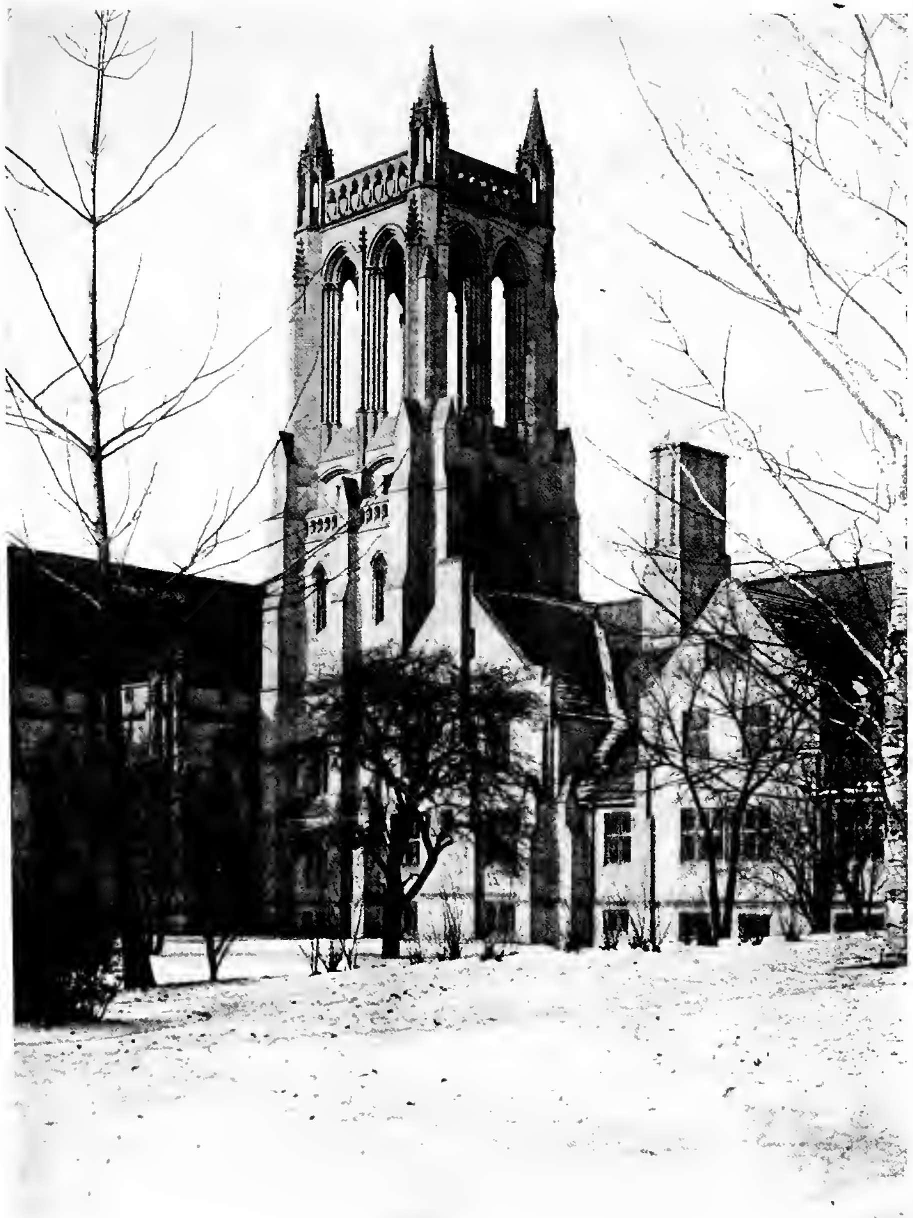
EMMANUEL PRESBYTERIAN CHURCH,
PHILADELPHIA, PA.

MESSRS. C. W. BOLTON & SON,
ARCHITECTS

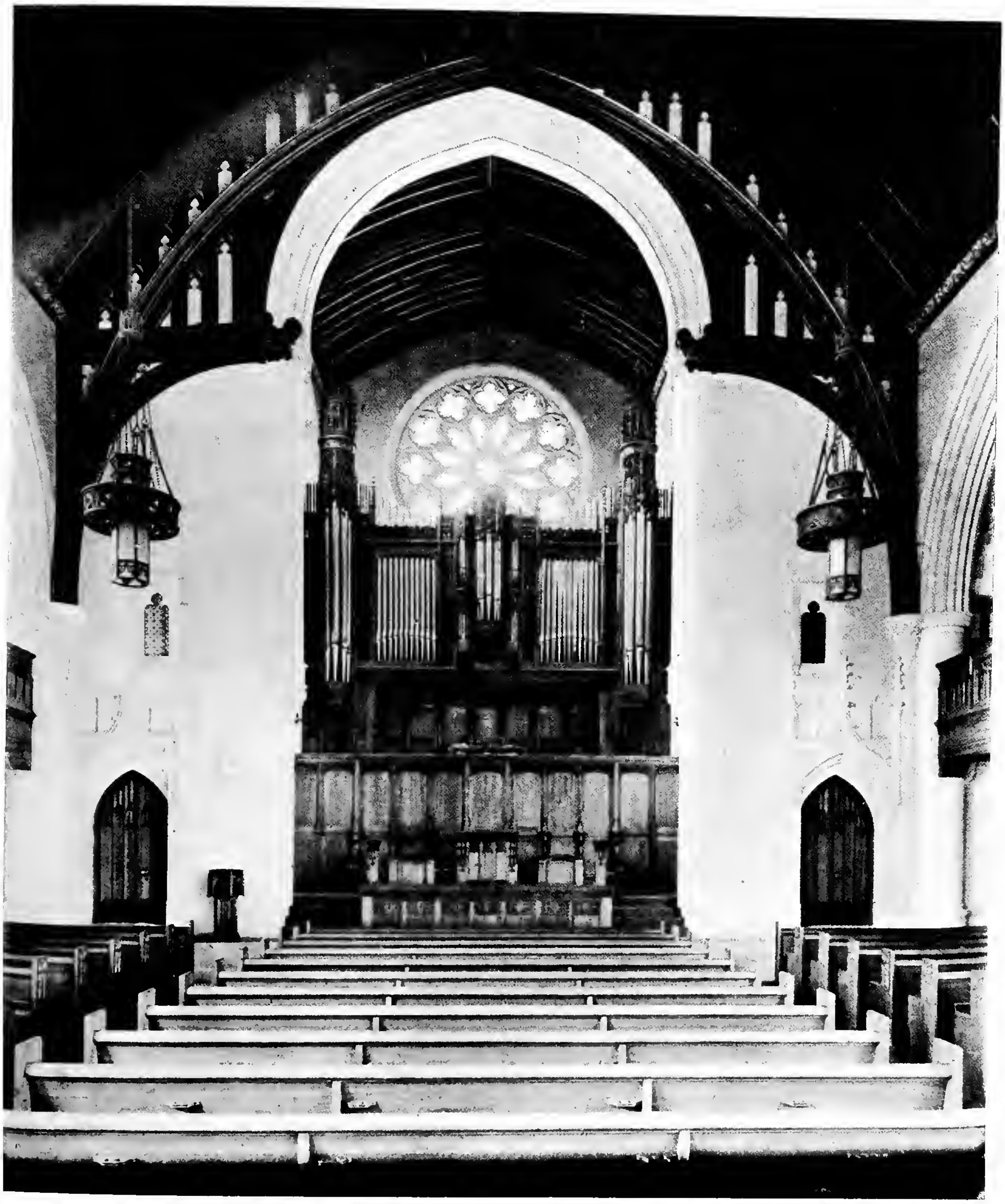
For views of these two churches see preceding pages

EUCLID AVENUE PRESBYTERIAN CHURCH, CLEVELAND, OHIO

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

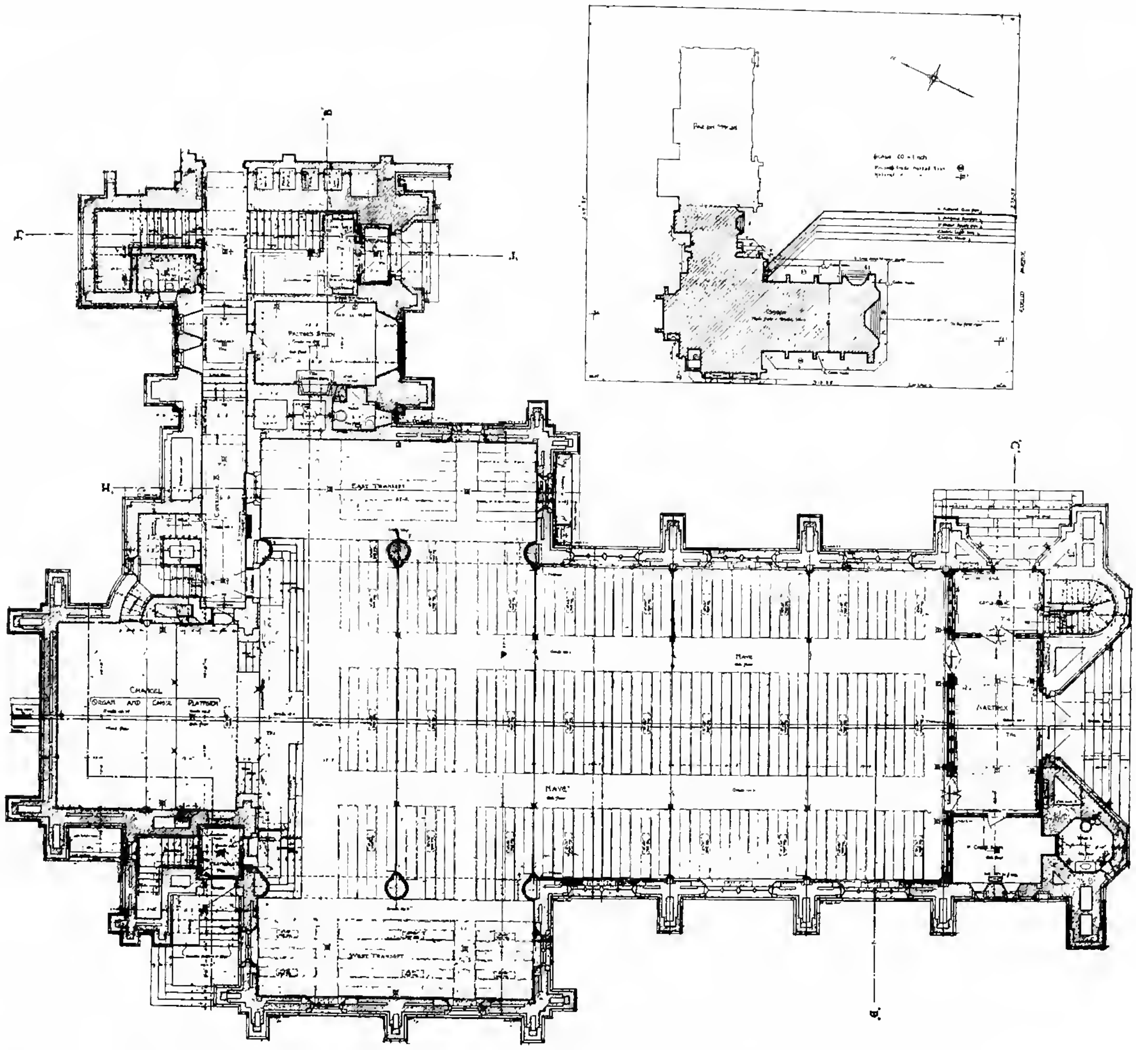


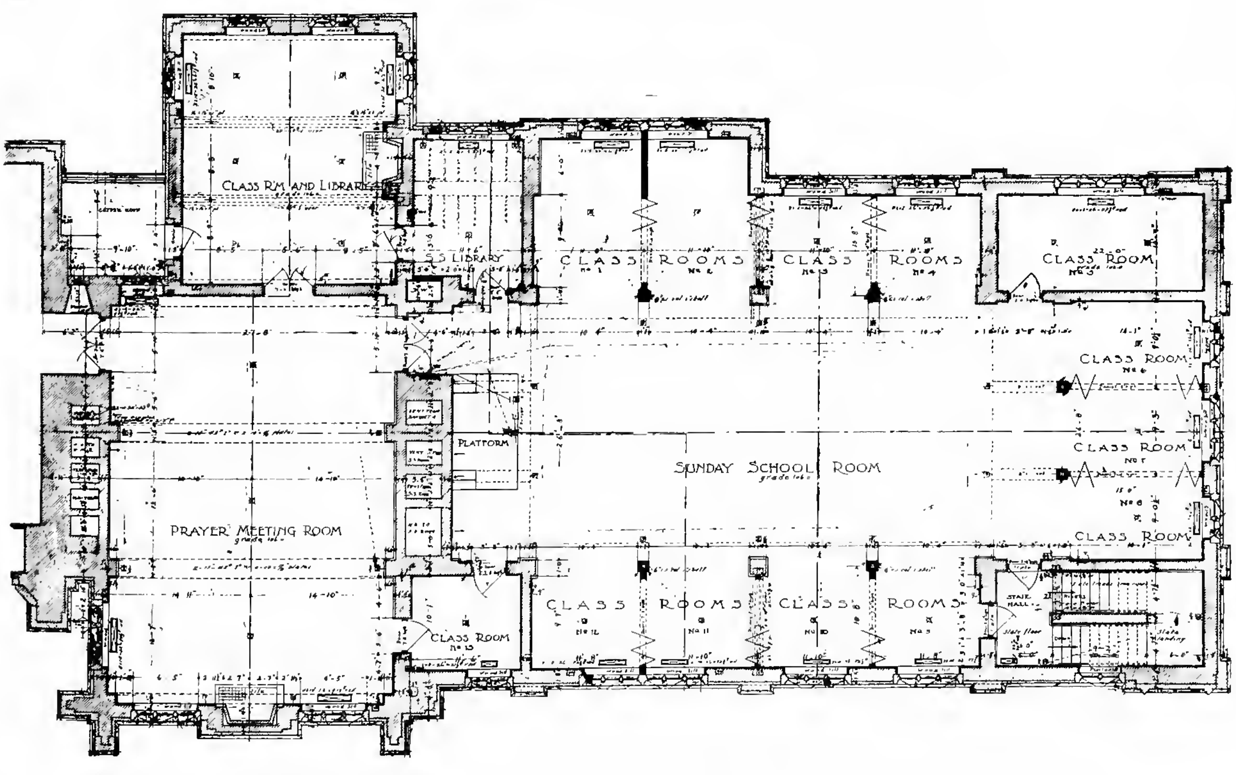
EUCLID AVENUE PRESBYTERIAN CHURCH, CLEVELAND, OHIO
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



EUCLID AVENUE PRESBYTERIAN CHURCH, CLEVELAND, OHIO

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

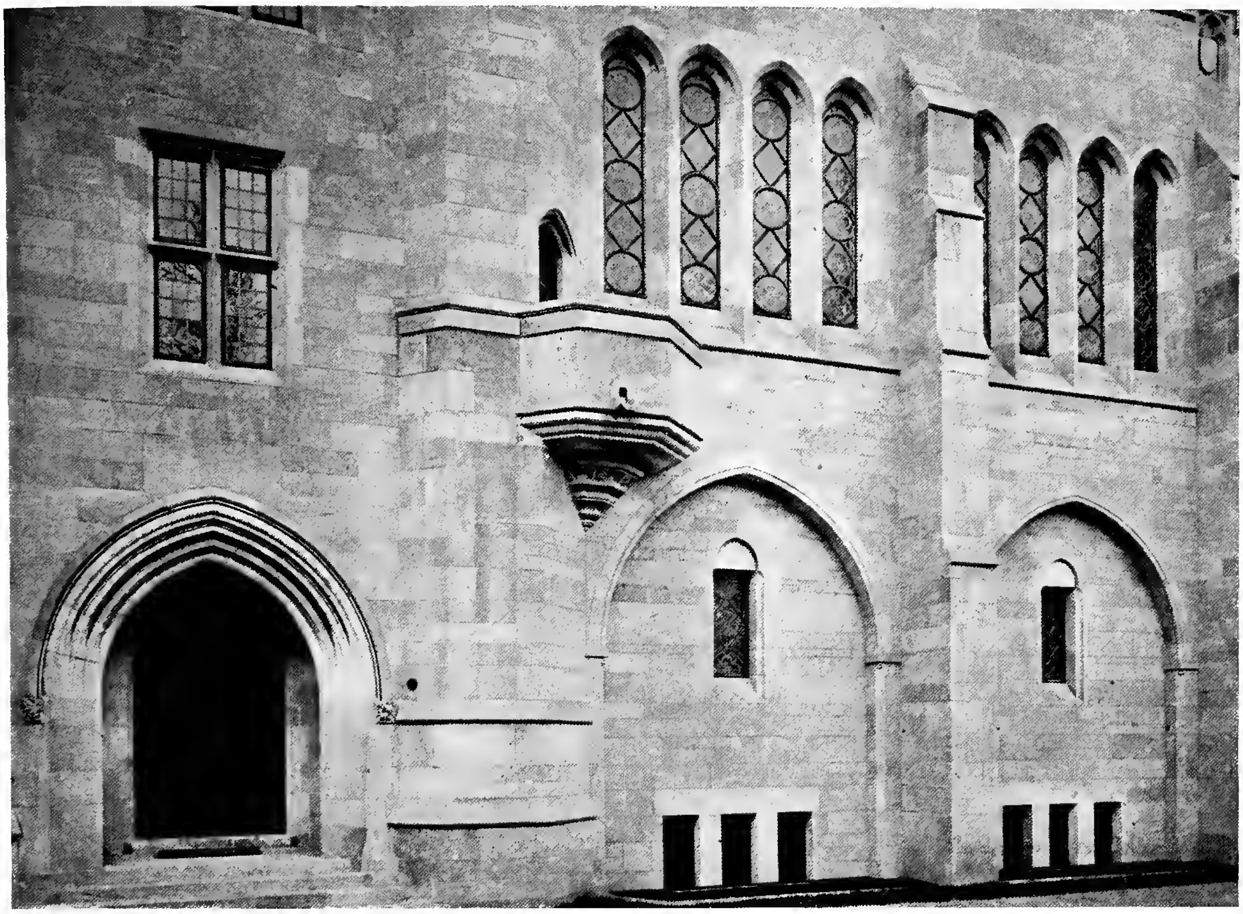




EUCLID AVENUE PRESBYTERIAN CHURCH, CLEVELAND, OHIO

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

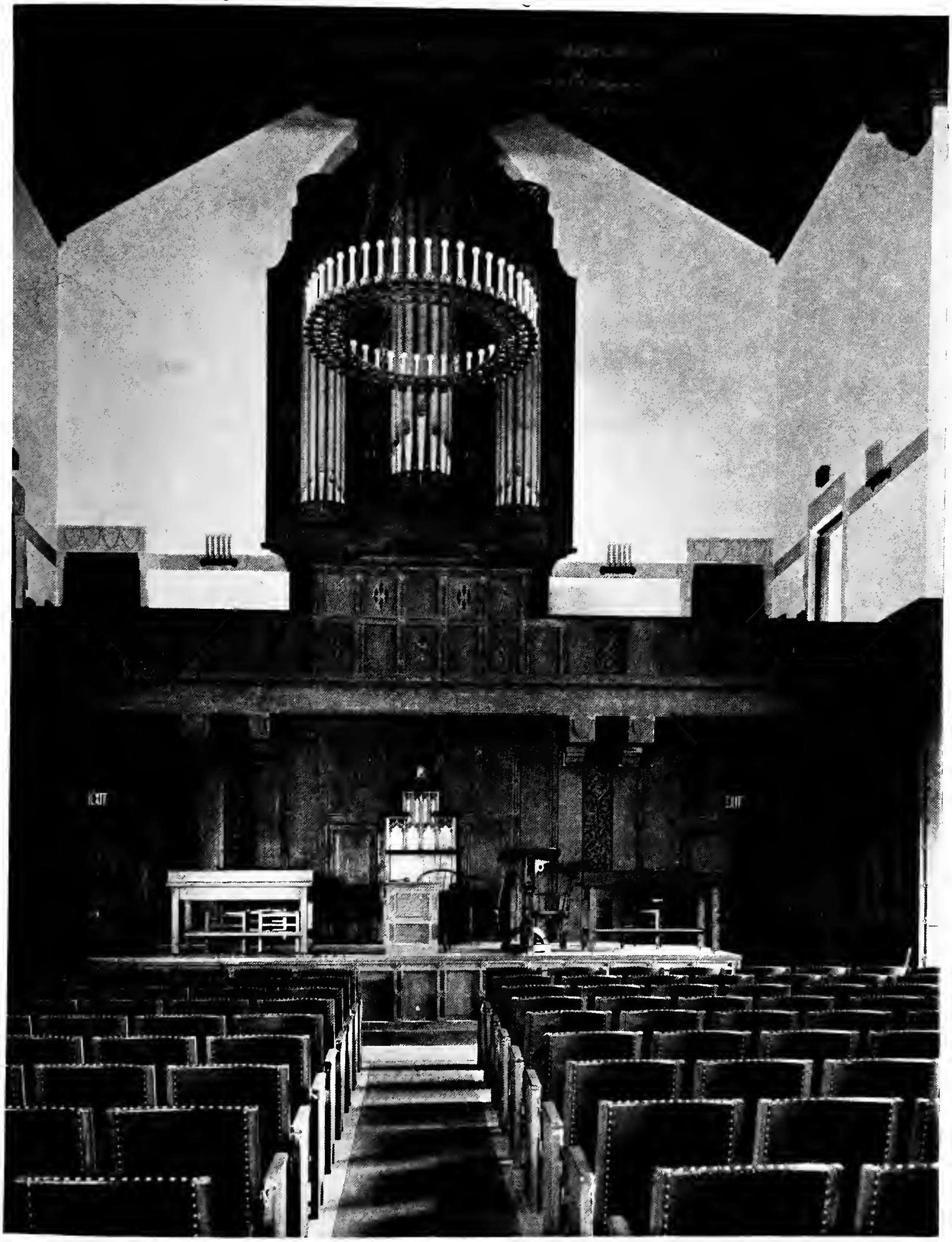
SYNOD HOUSE, CATHEDRAL OF ST. JOHN THE DIVINE, NEW YORK
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



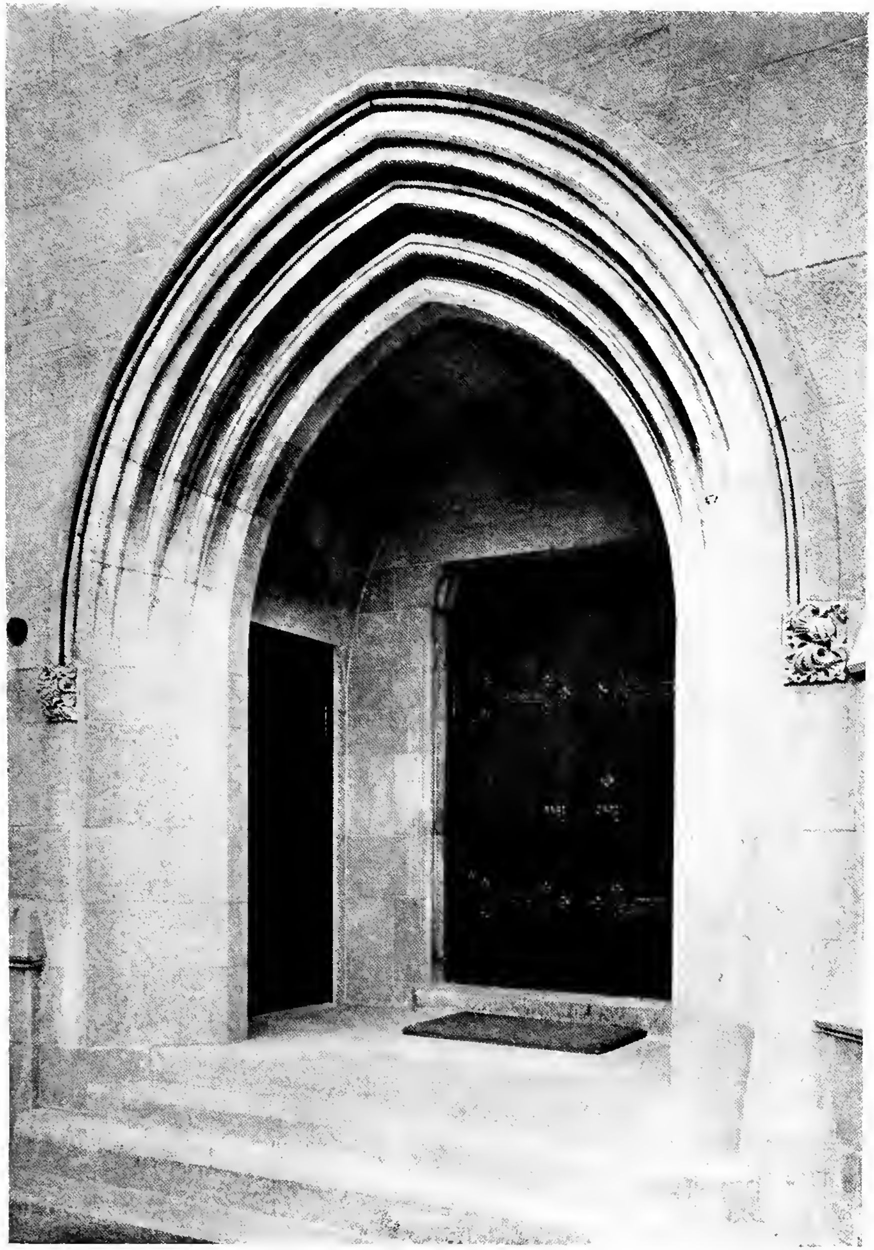
SYNOD HOUSE, CATHEDRAL OF ST. JOHN THE DIVINE, NEW YORK
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

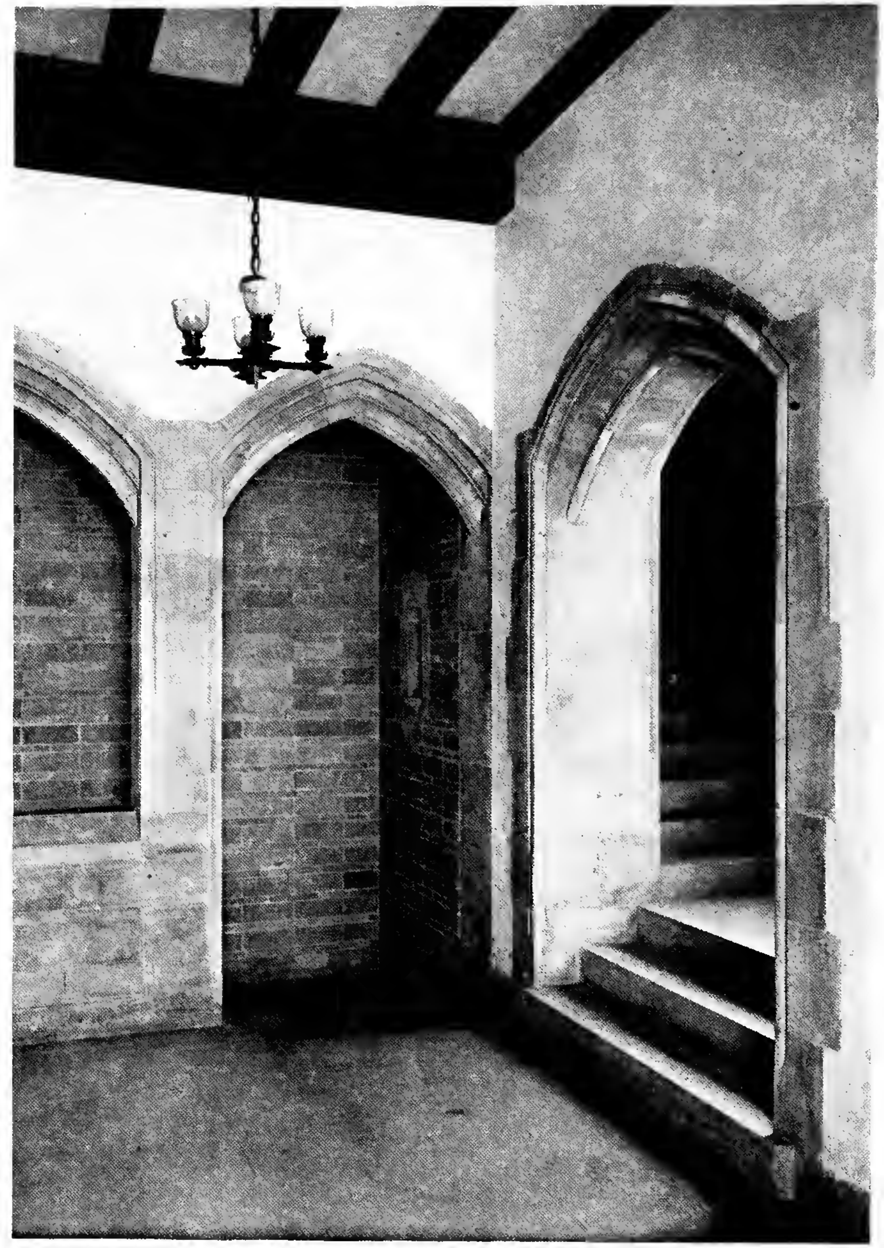
SYNOD HOUSE, CATHEDRAL OF ST. JOHN THE DIVINE, NEW YORK

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



SYNOD HOUSE, CATHEDRAL OF ST. JOHN THE DIVINE, NEW YORK
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



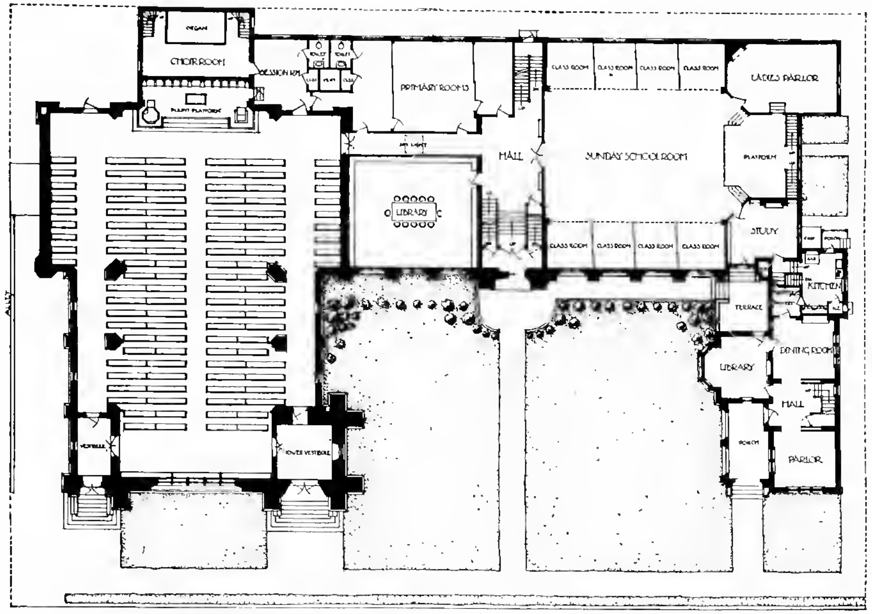


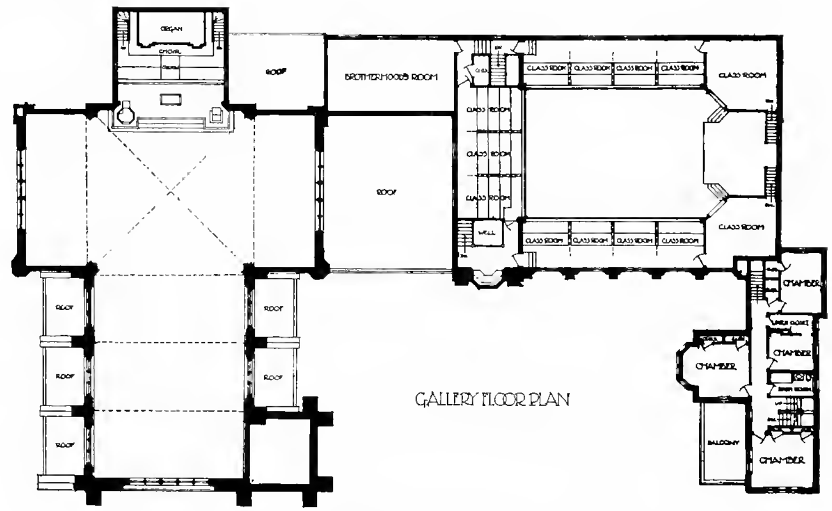
SYNOD HOUSE, CATHEDRAL OF ST. JOHN THE DIVINE, NEW YORK
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

SYNOD HOUSE, CATHEDRAL OF ST. JOHN THE DIVINE, NEW YORK

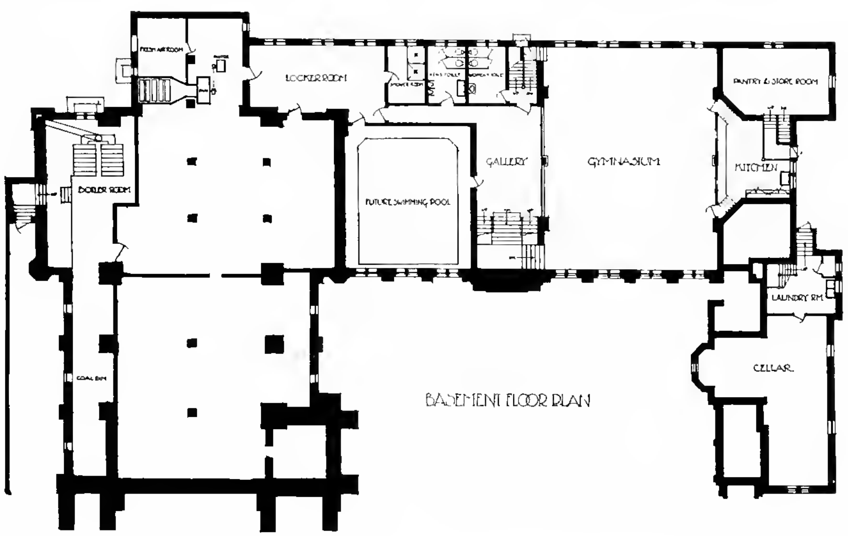
MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*

RICHARDSON MEMORIAL PRESBYTERIAN CHURCH, PHILADELPHIA, PA.
MESSRS. CHARLES W. BOLTON & SON, *ARCHITECTS*





FLOOR PLANS



RICHARDSON MEMORIAL PRESBYTERIAN CHURCH,
PHILADELPHIA, PA.

MESSRS. CHARLES W. BOLTON & SON,
ARCHITECTS

RICHARDSON MEMORIAL PRESBYTERIAN CHURCH, PHILADELPHIA, PA.
MESSRS. CHARLES W. BOLTON & SON, *ARCHITECTS*

CHANCEL

TOWER ENTRANCE

RICHARDSON MEMORIAL PRESBYTERIAN CHURCH, PHILADELPHIA, PA.
MESSRS. CHARLES W. BOLTON & SON, *ARCHITECTS*

FLAGLER MEMORIAL CHURCH, ST. AUGUSTINE, FLA.
MESSRS. CARRERE & HASTINGS, *ARCHITECTS*

VIEW FROM SOUTHWEST

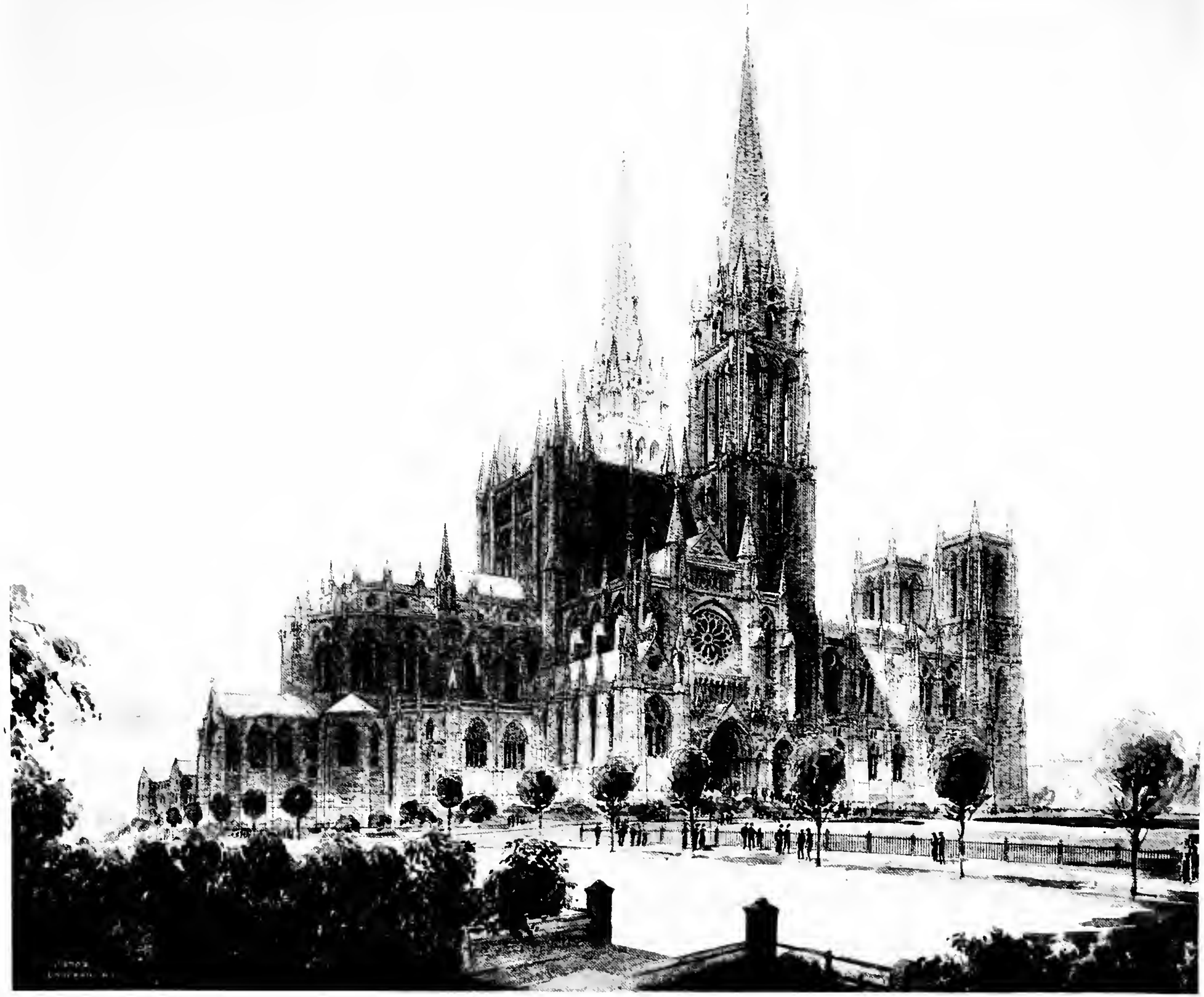
PROPOSED DESIGN FOR THE COMPLETION OF THE CATHEDRAL OF ST. JOHN THE DIVINE, NEW YORK

RALPH ADAMS CRAM, *CONSULTING ARCHITECT*

VIEW FROM NORTHWEST

PROPOSED DESIGN FOR COMPLETION OF THE CATHEDRAL OF ST. JOHN THE DIVINE, NEW YORK

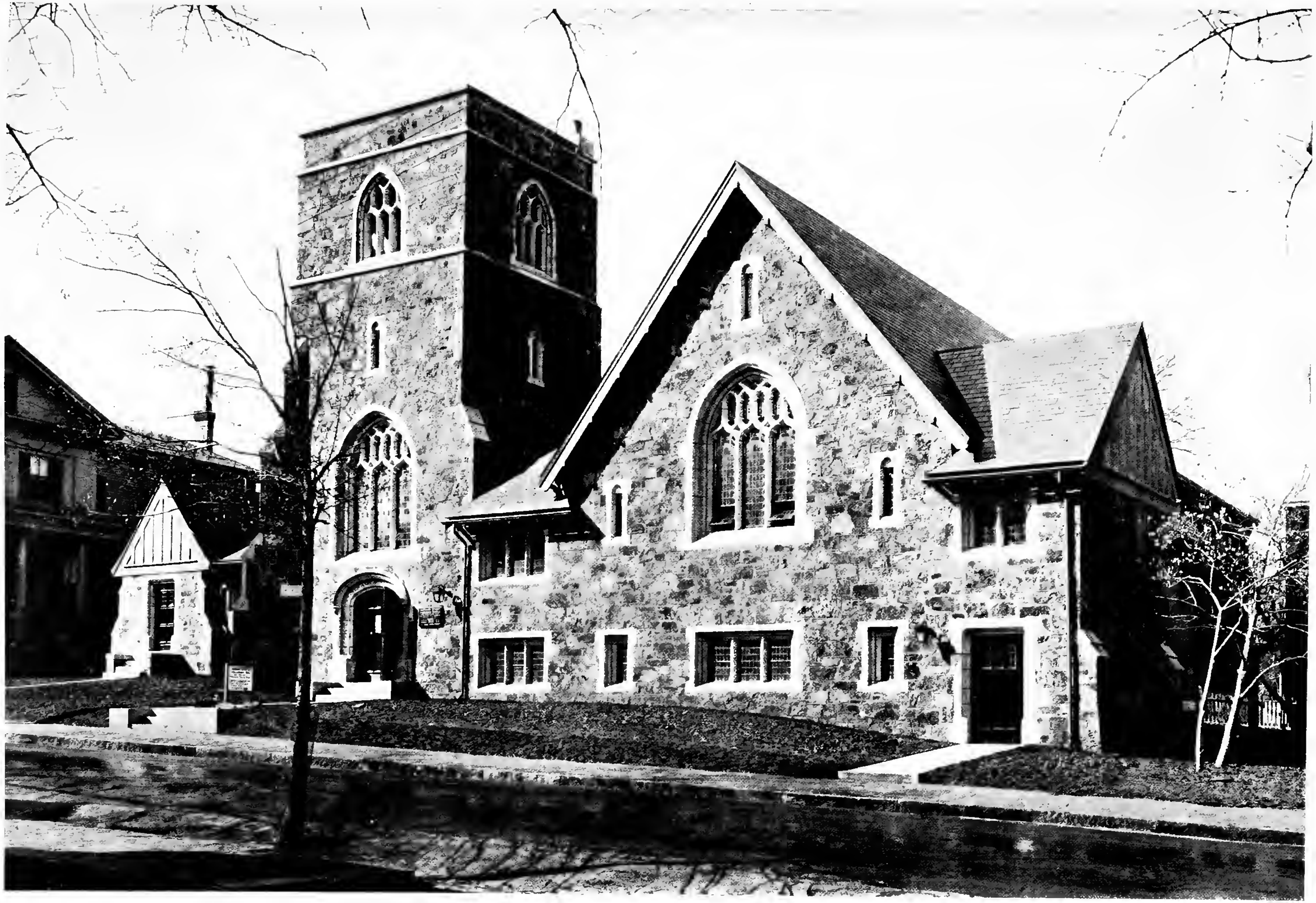
RALPH ADAMS CRAM, *CONSULTING ARCHITECT*



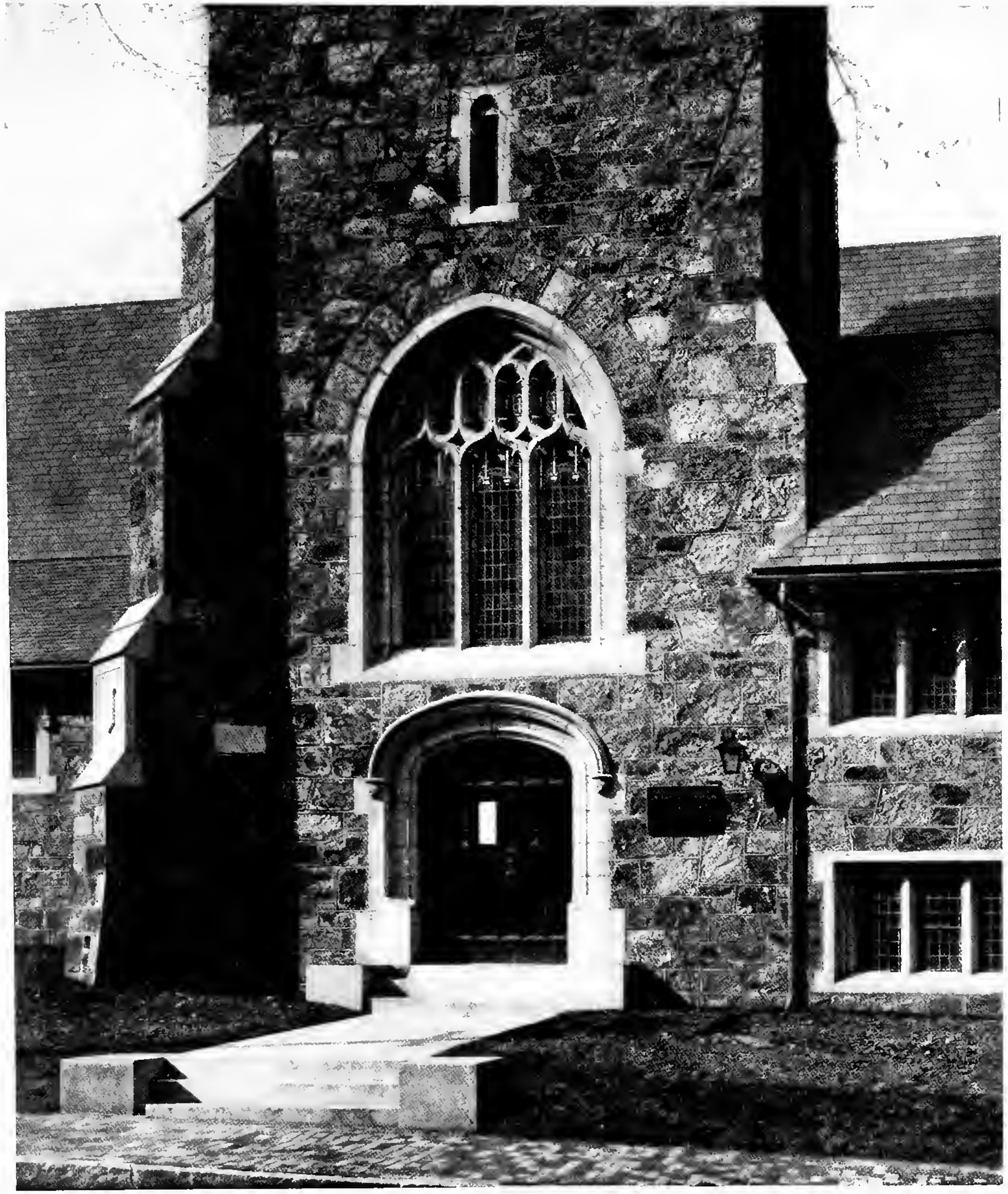
VIEW FROM NORTHEAST

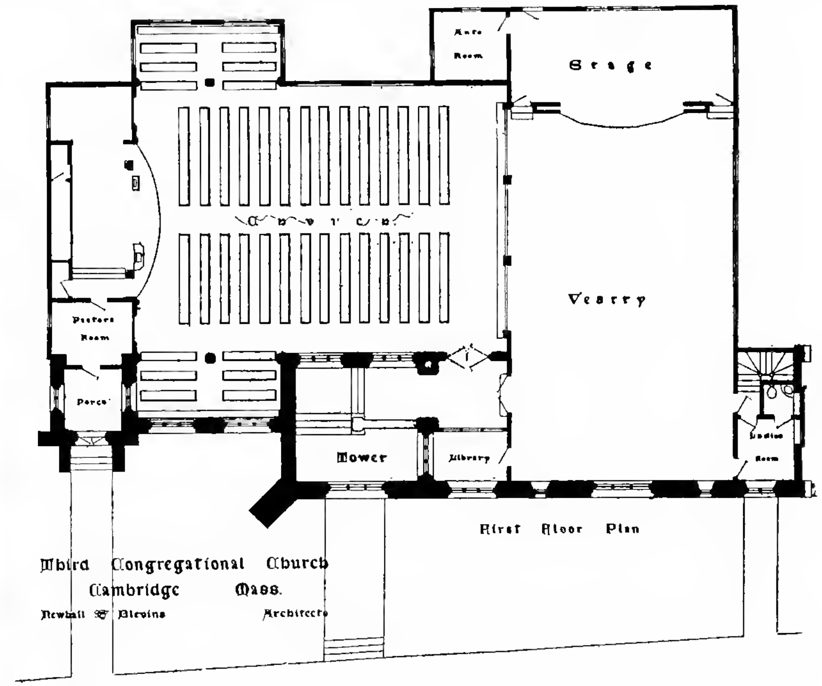
PROPOSED DESIGN FOR COMPLETION OF THE CATHEDRAL OF ST. JOHN THE DIVINE, NEW YORK

RALPH ADAMS CRAM, *CONSULTING ARCHITECT*



THIRD CONGREGATIONAL CHURCH, CAMBRIDGE, MASS.
MESSRS. NEWHALL & BLEVINS, *ARCHITECTS*



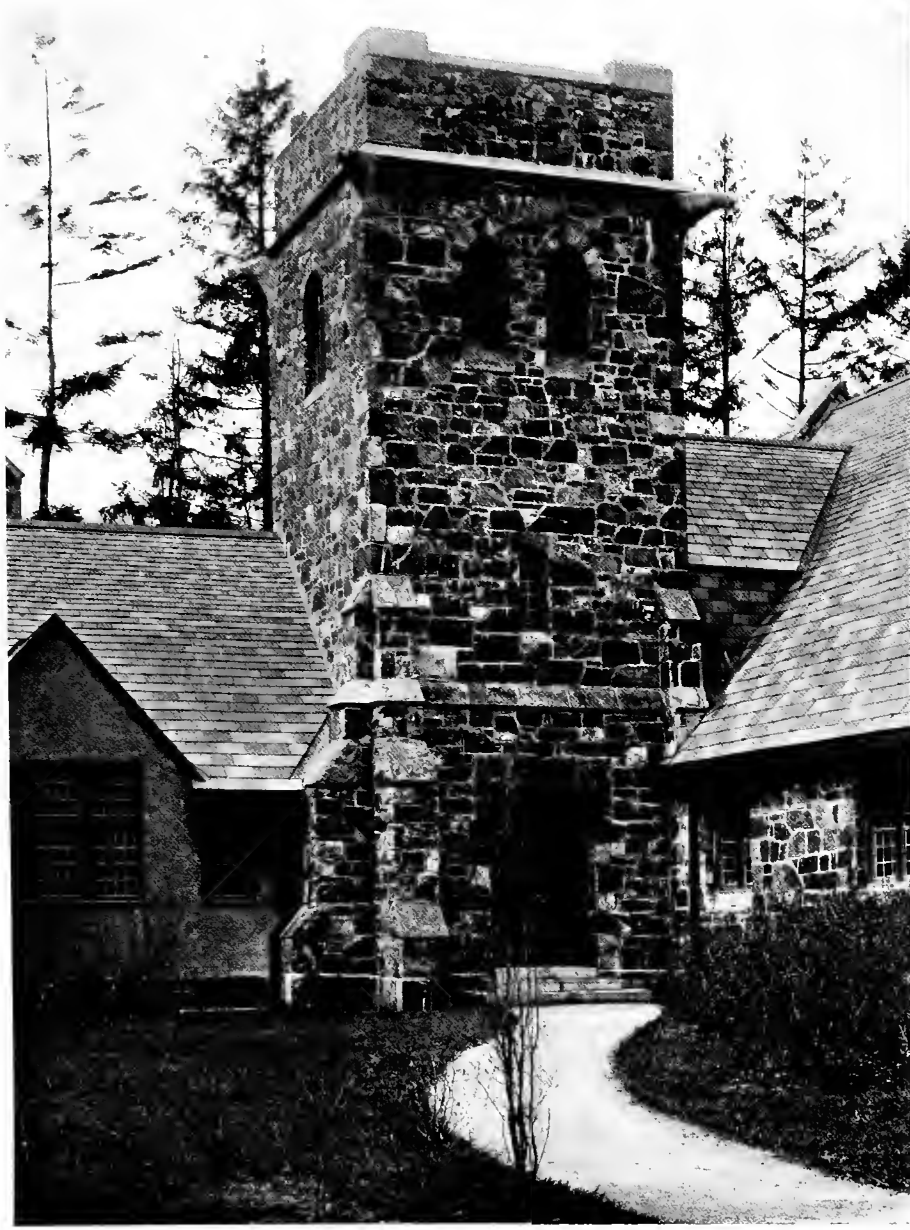


THIRD CONGREGATIONAL CHURCH,
CAMBRIDGE, MASS.

MESSRS. NEWHALL & BLEVINS, *ARCHITECTS*

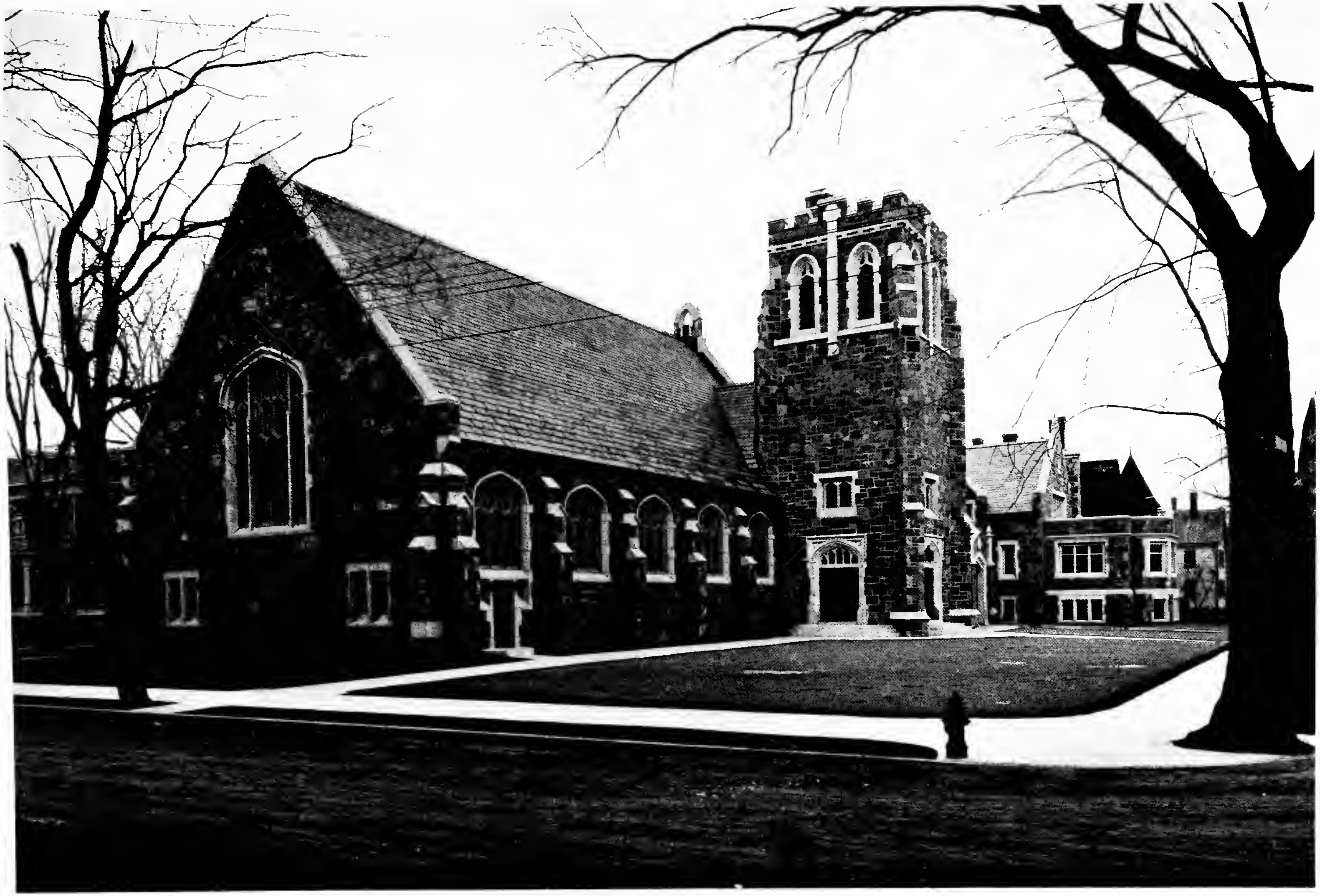
FIRST CHURCH, CHESTNUT HILL, MASS.

MR. J. LOVELL LITTLE, JR., *ARCHITECT*



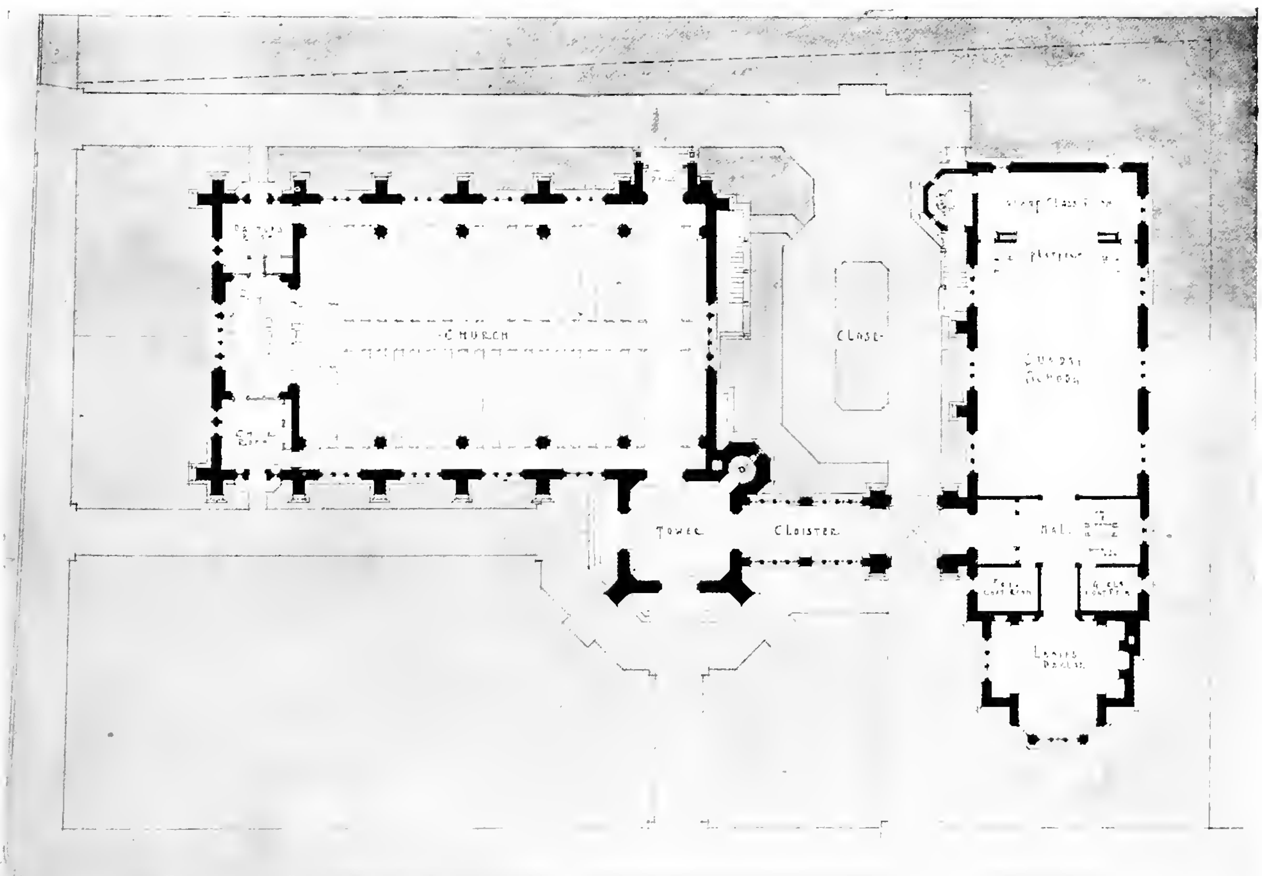
FIRST CHURCH, CHESTNUT HILL, MASS.

MR. J. LOVELL LITTLE, JR., *ARCHITECT*



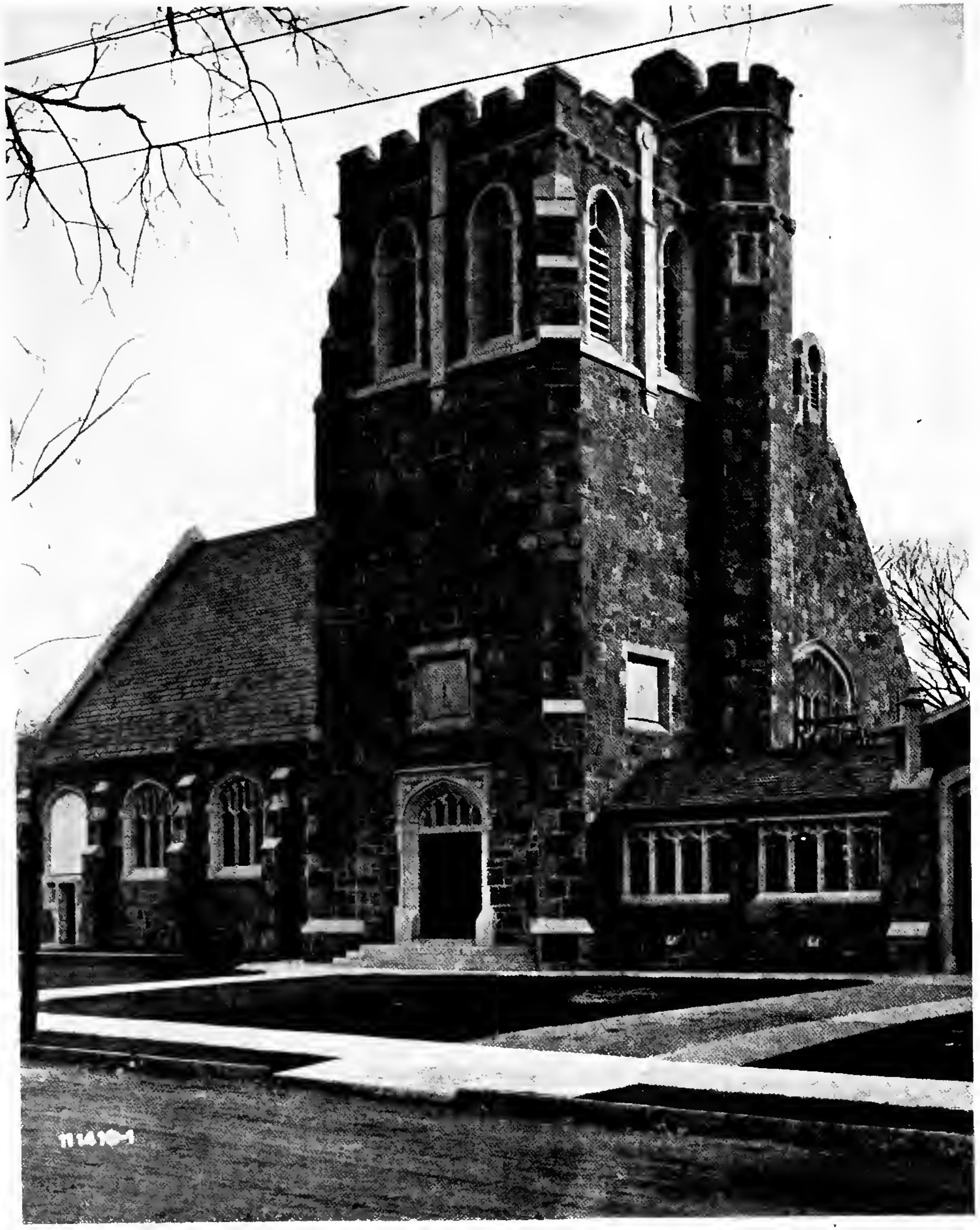
SECOND CONGREGATIONAL CHURCH, LYNN, MASS.
MESSRS. NELSON & VAN WAGENEN AND MR. GEORGE H. BREED, *ASSOCIATE ARCHITECTS*

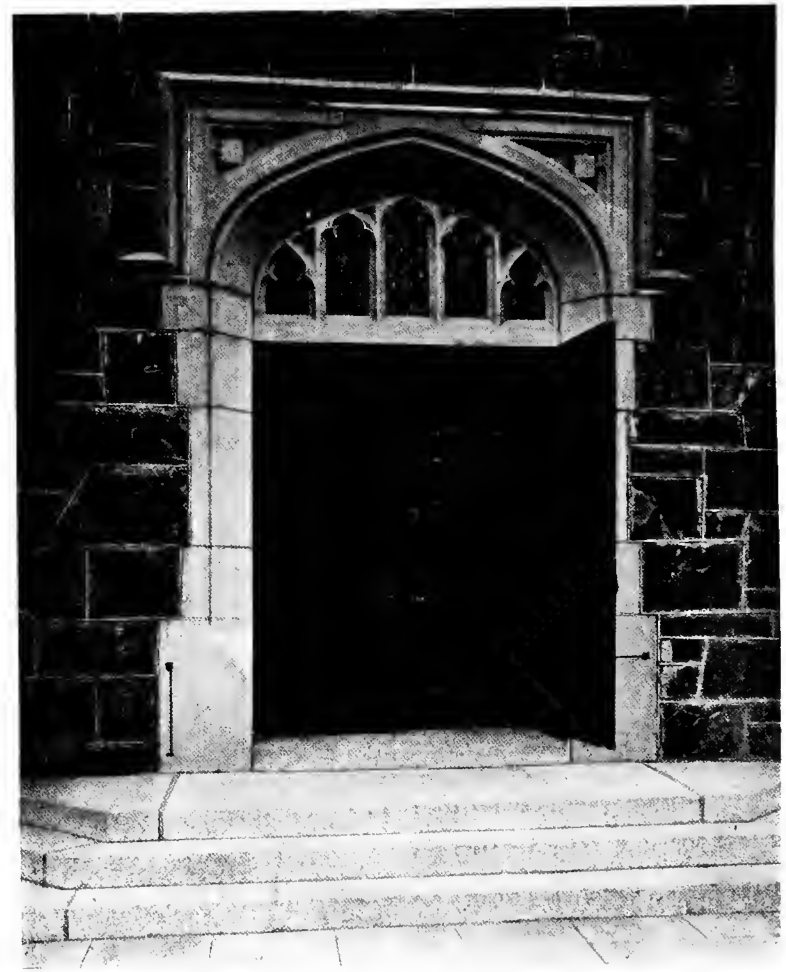
SECOND CONGREGATIONAL CHURCH, LYNN, MASS.
MESSRS. NELSON & VAN WAGENEN AND MR. GEORGE H. BREED, *ASSOCIATE ARCHITECTS*



SECOND CONGREGATIONAL CHURCH, LYNN, MASS.

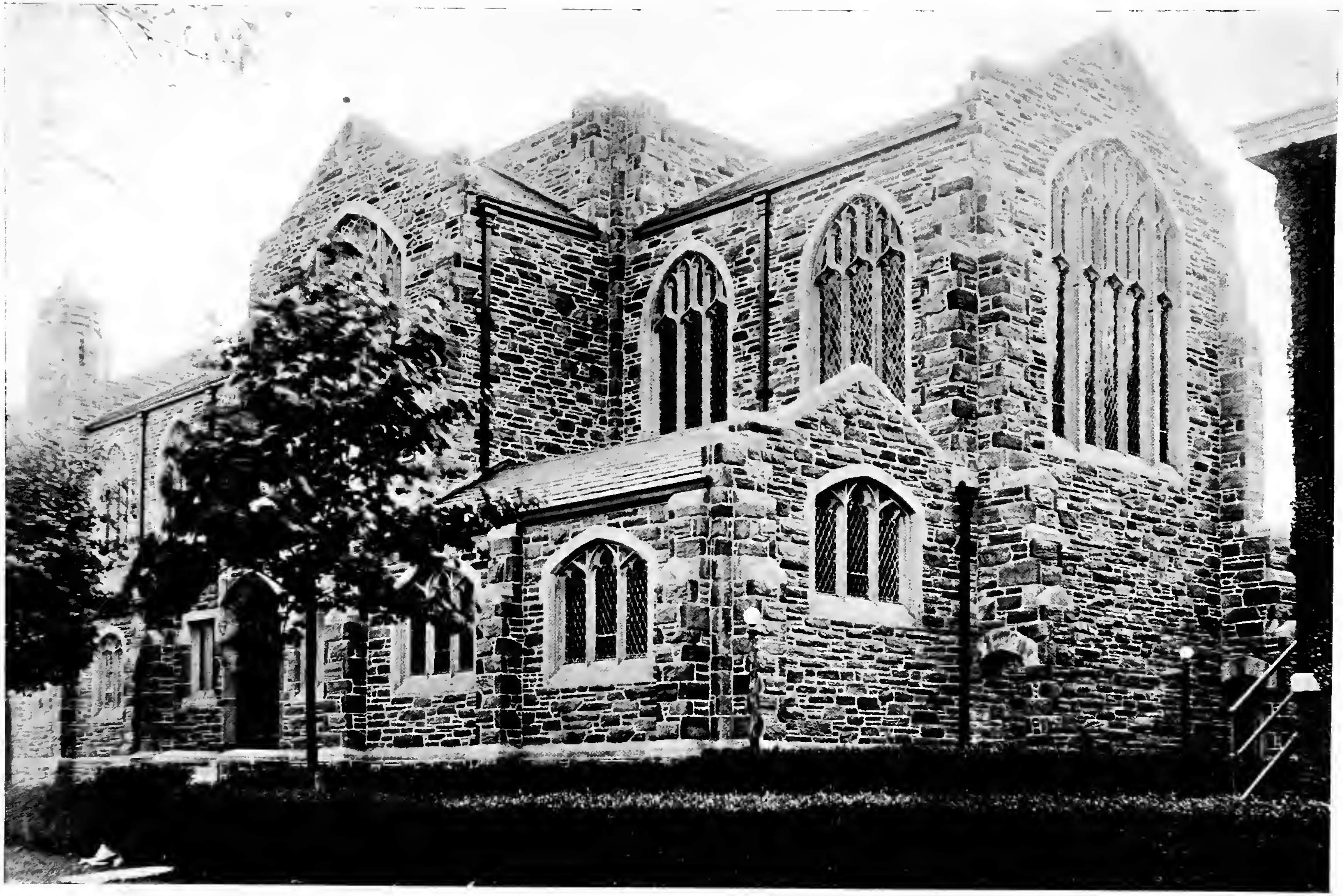
MESSRS. NELSON & VAN WAGENEN AND MR. GEORGE H. BREED, *ASSOCIATE ARCHITECTS*





SECOND CONGREGATIONAL CHURCH, LYNN, MASS.

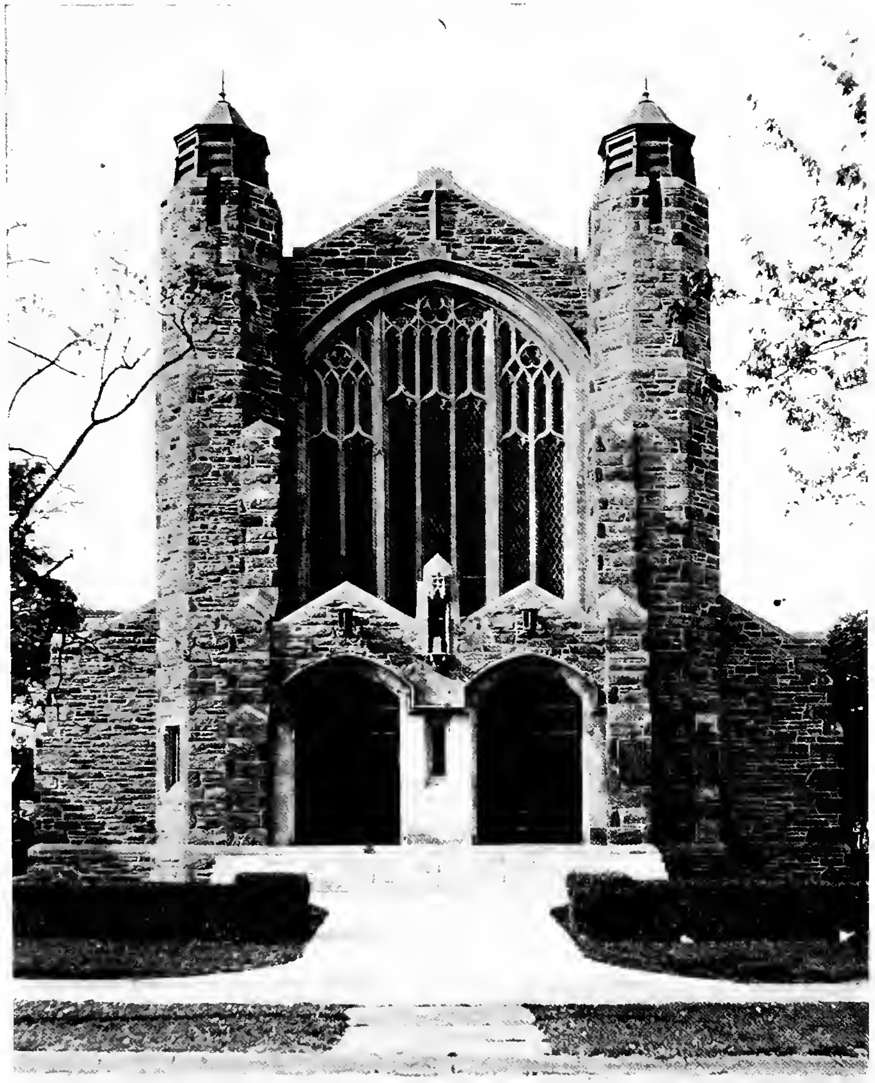
MESSRS. NELSON & VAN WAGENEN AND
MR. GEORGE H. BREED, *ASSOCIATE ARCHITECTS*



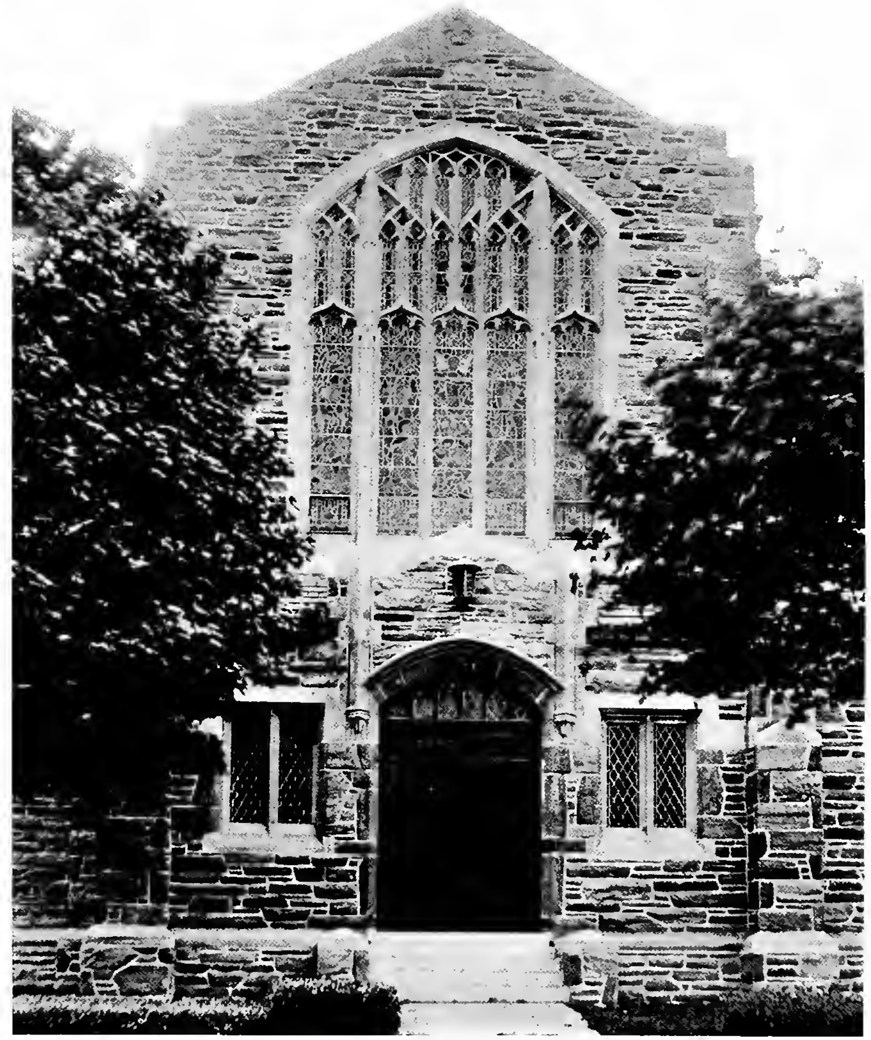
REAR VIEW

TRINITY CHURCH, ASBURY PARK, N. J.
MR. CLARENCE W. BRAZER, *ARCHITECT*

This church is constructed of Chestnut Hill, Pa., rubble stone with buffed Indiana limestone trimmings. The window tracery and the entire interior is of a manufactured limestone. The vestibules, main aisle, chancel and chapel have reenforced concrete floors, laid over with tile. Steps and borders are all green purple slate. The furniture is of temporary installation and will be replaced later with specially designed furniture. The central tower is unfinished, and will probably not be built for several years. The pews are of oak and the lighting fixtures of solid brass.



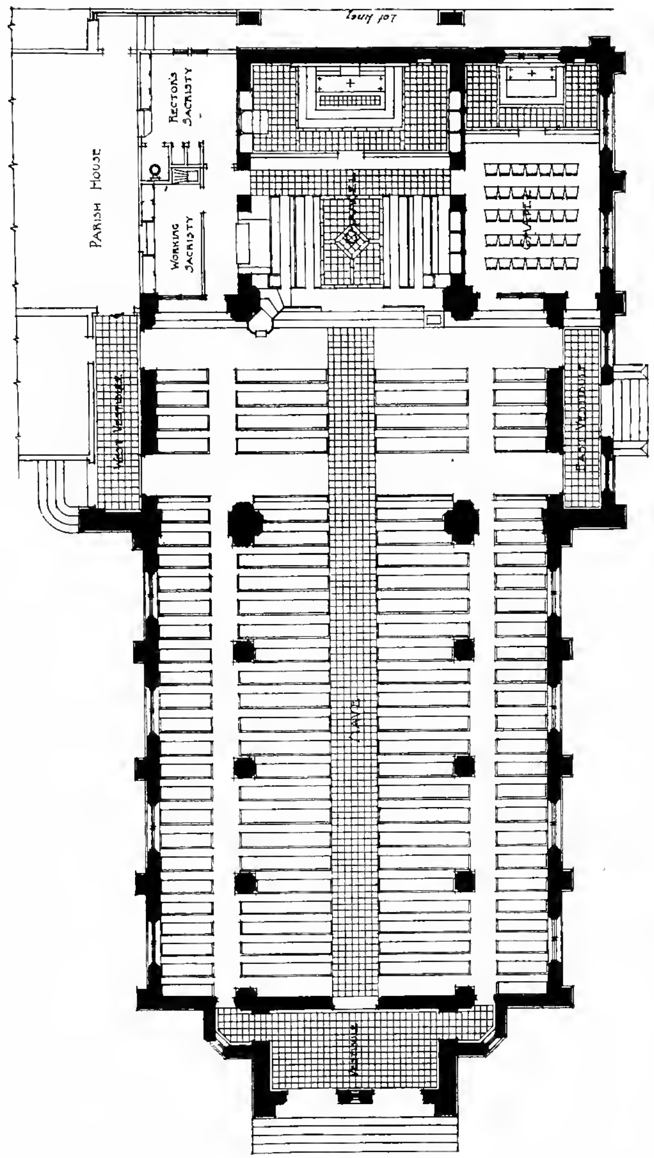
FRONT VIEW



TRANSEPT

TRINITY CHURCH, ASBURY PARK, N. J.

MR. CLARENCE W. BRAZER, *ARCHITECT*

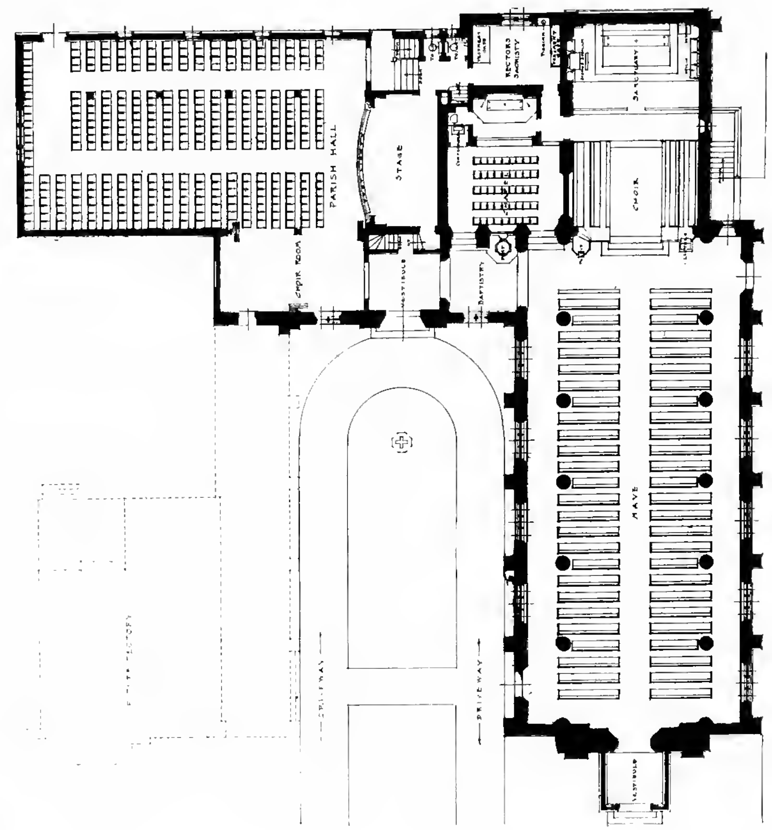


TRINITY CHURCH, ASBURY PARK, N. J.
MR. CLARENCE W. BRAZER, *ARCHITECT*

ST. JAMES CHURCH, LONG BRANCH, N. J.

MESSRS. BRAZER & ROBB, *ARCHITECTS*

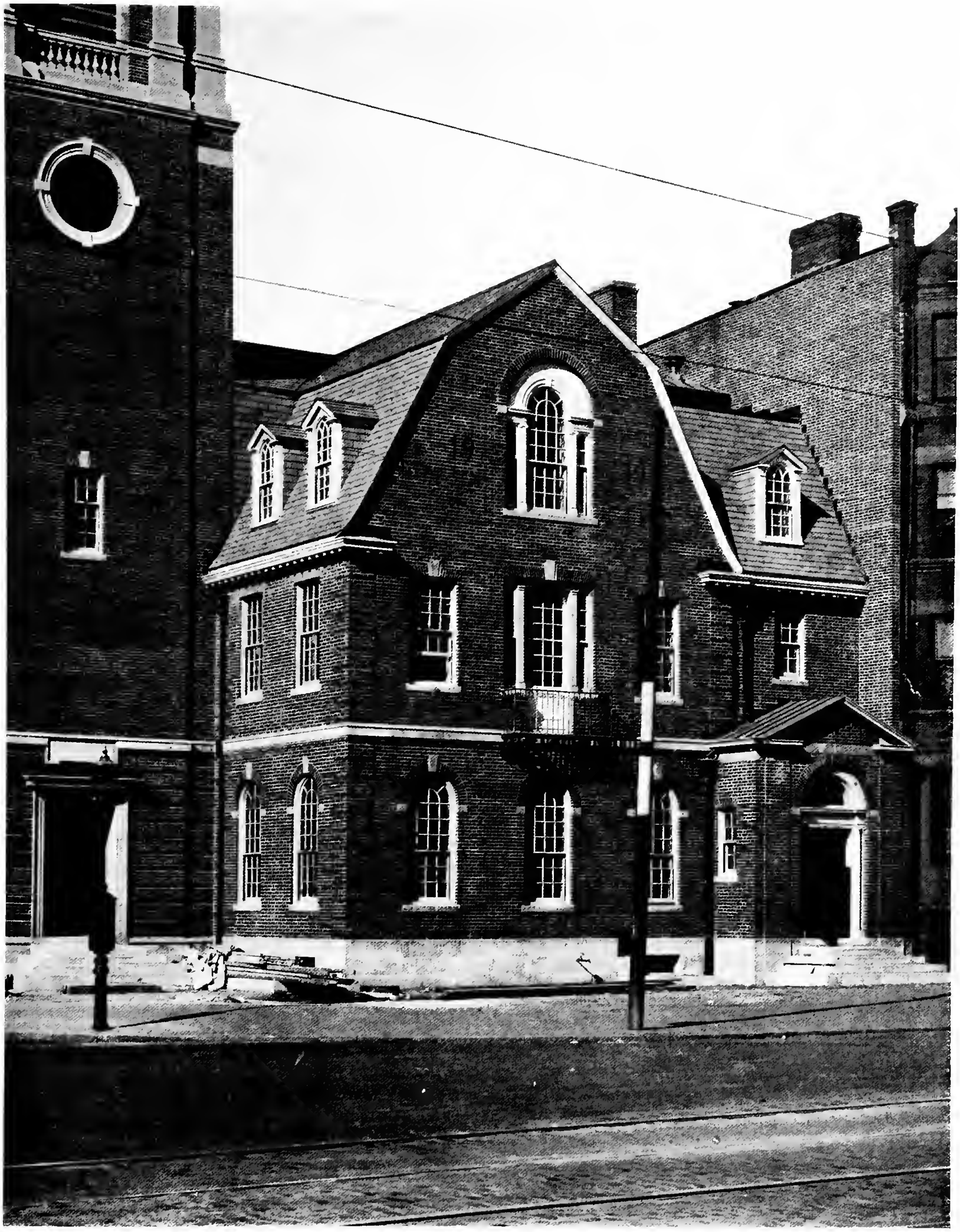
This church is constructed of Chestnut Hill, Pa., stone, with concrete trimming tracery columns and arches. The floor is also of concrete and is laid directly on the level of the nave, but has pipe trenches under reenforced concrete floors in the aisles. The ceiling is of North Carolina pine, stained a nut brown, and the chancel ceiling is stenciled and painted in three colors. All the chancel furniture is temporary. The lighting fixtures are of cast brass, silver-plated. The cost to date of this church is $.189 per cubic foot.



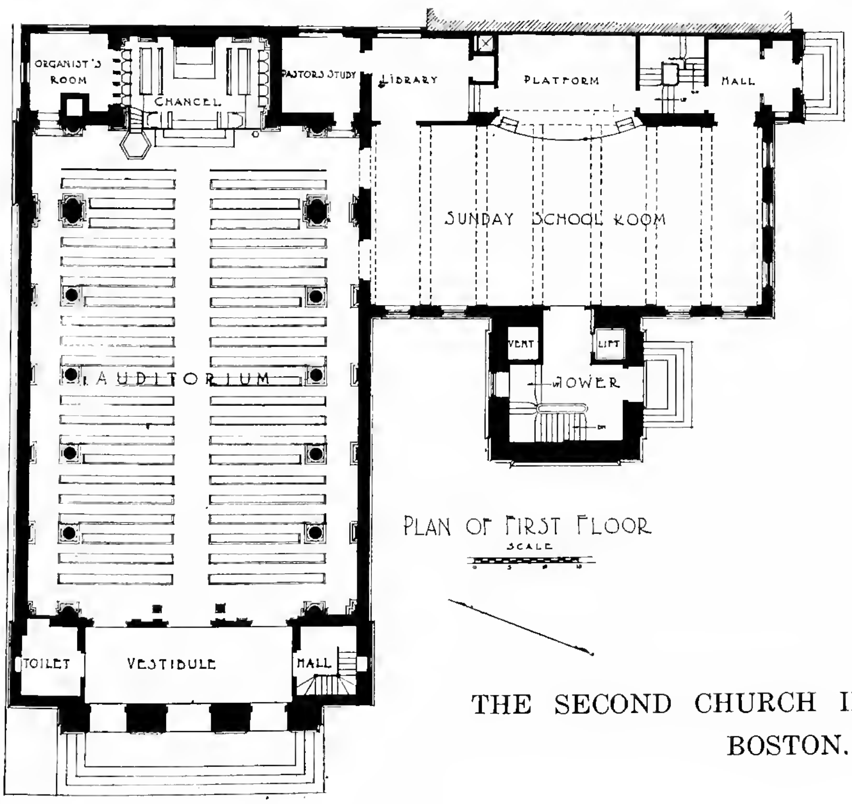
ST. JAMES CHURCH, LONG BRANCH, N. J.

MESSRS. BRAZER & ROBB, *ARCHITECTS*

THE SECOND CHURCH IN BOSTON, UNITARIAN
MESSRS. CRAM & FERGUSON, *ARCHITECTS*



THE SECOND CHURCH IN BOSTON, UNITARIAN
MESSRS. CRAM & FERGUSON, *ARCHITECTS*



MESSRS. CRAM & FERGUSON,
ARCHITECTS

THE SECOND CHURCH IN BOSTON, UNITARIAN
BOSTON, MASS.

THE SECOND CHURCH IN BOSTON, UNITARIAN
MESSRS. CRAM & FERGUSON, *ARCHITECTS*

THE SECOND CHURCH IN BOSTON, UNITARIAN

MESSRS. CRAM & FERGUSON, *ARCHITECTS*

THE SECOND CHURCH IN BOSTON, UNITARIAN

MESSRS. CRAM & FERGUSON, *ARCHITECTS*

THE SECOND CHURCH IN BOSTON, UNITARIAN
MESSRS. CRAM & FERGUSON, *ARCHITECTS*

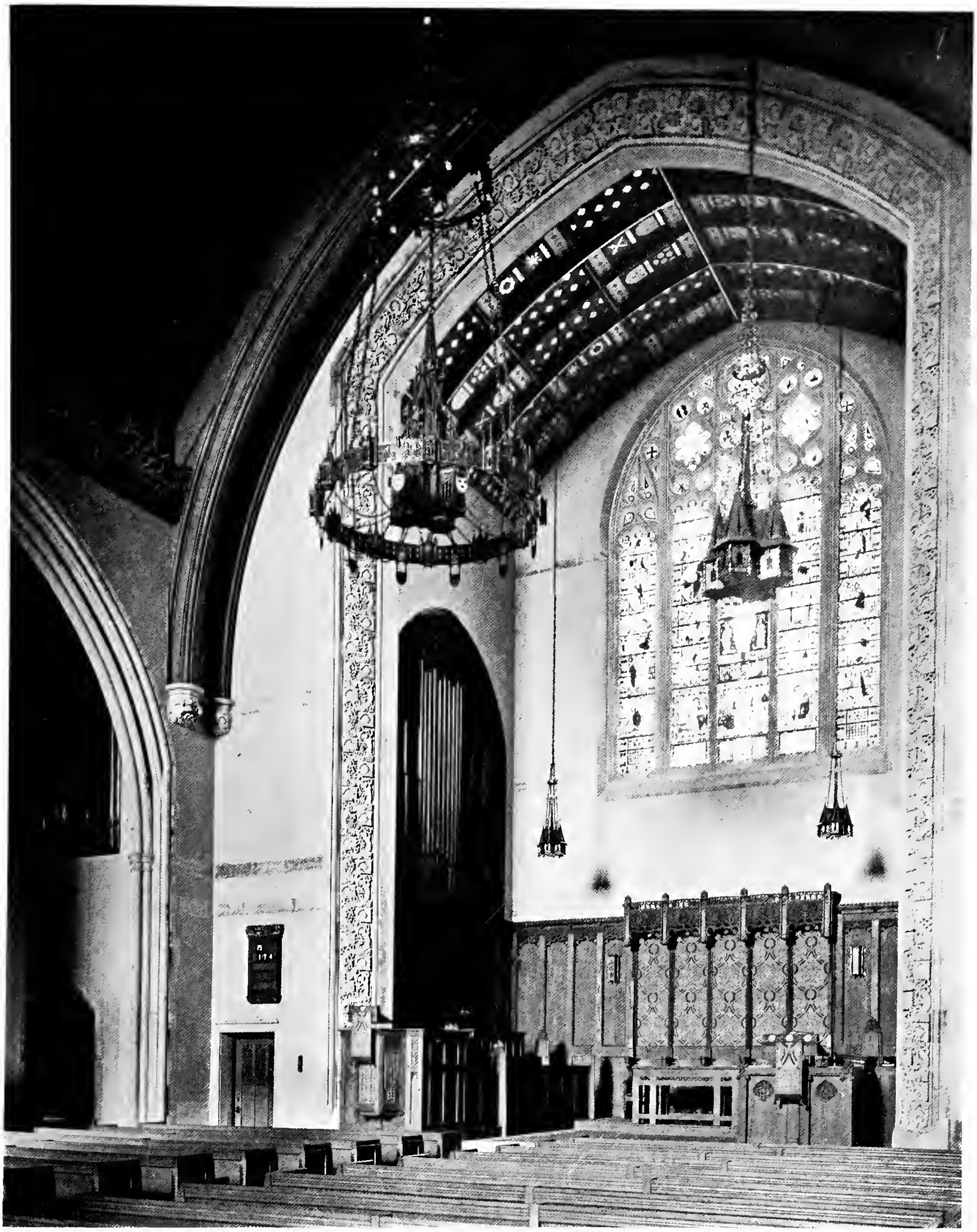
THE SECOND CHURCH IN BOSTON, UNITARIAN

MESSRS. CRAM & FERGUSON, *ARCHITECTS*

CHURCH AND PARISH HOUSE FROM SOUTHWEST

THE HOUSE OF HOPE PRESBYTERIAN CHURCH, ST. PAUL, MINN.

MESSRS. CRAM, GOODHUE & FERGUSON (BOSTON OFFICE), *ARCHITECTS*



THE CHANCEL FROM THE NAVE

THE HOUSE OF HOPE PRESBYTERIAN CHURCH, ST. PAUL, MINN.

MESSRS. CRAM, GOODHUE & FERGUSON, (BOSTON OFFICE) *ARCHITECTS.*

CHURCH AND PARISH HOUSE, FROM NORTHEAST.

THE HOUSE OF HOPE PRESBYTERIAN CHURCH, ST. PAUL, MINN.

MESSRS. CRAM, GOODHUE & FERGUSON, (BOSTON OFFICE) *ARCHITECTS.*

EAST SIDE OF NAVE

THE HOUSE OF HOPE PRESBYTERIAN CHURCH, ST. PAUL, MINN.

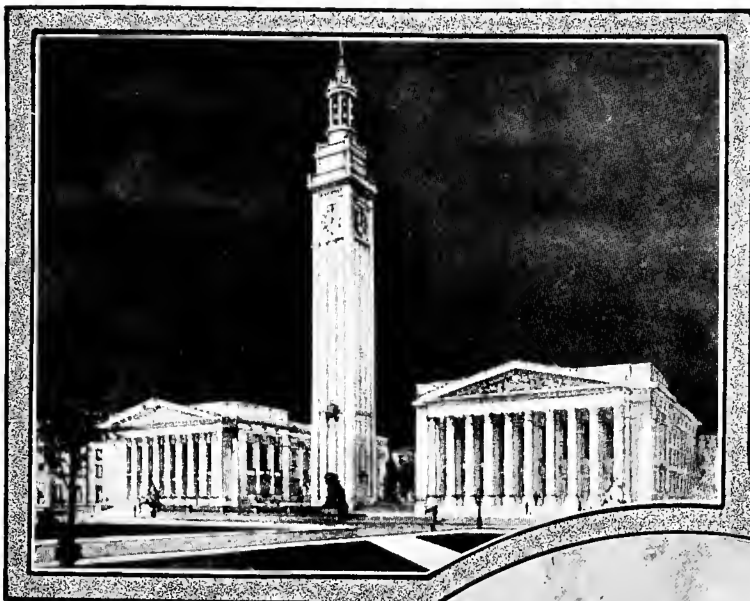
MESSRS. CRAM, GOODHUE & FERGUSON, (BOSTON OFFICE) *ARCHITECTS.*

INDEX

TEXT

PLATES

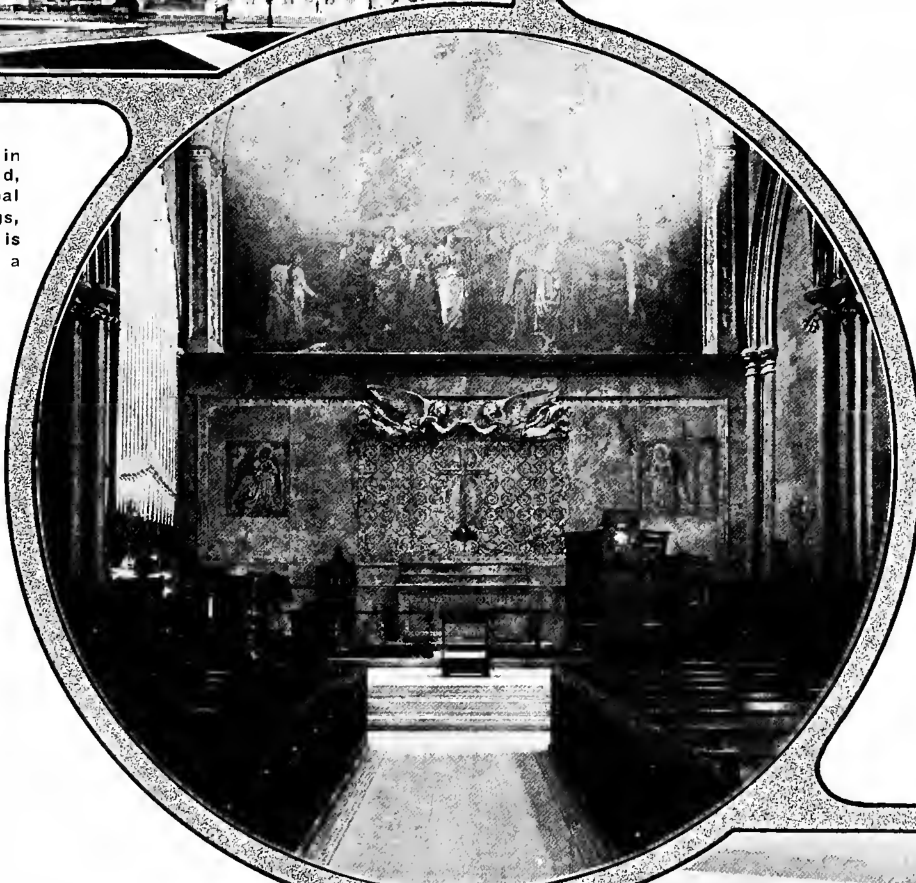
The figures refer to plate numbers except where TEXT is stated



Organs

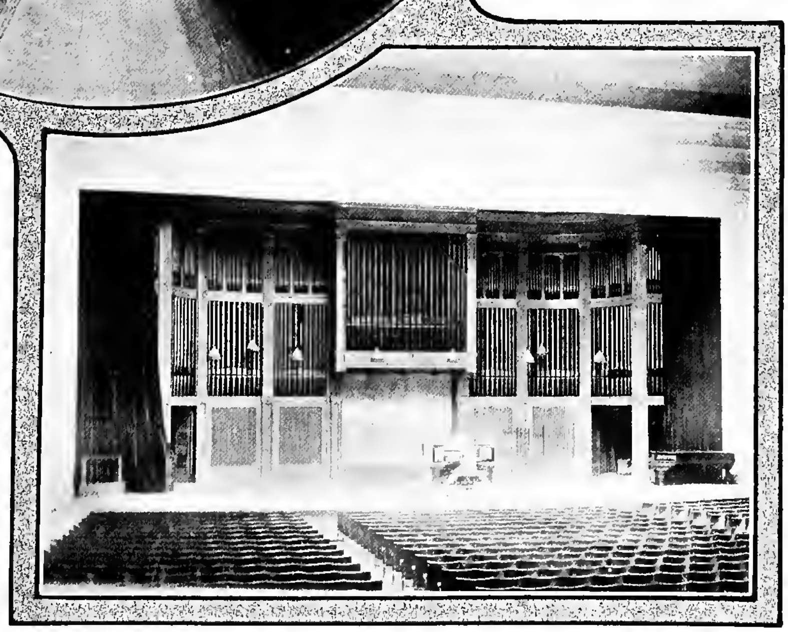
Steere Organs are unsurpassed in quality of material and their system is the simplest known. Accessibility of every part is one of their strong features of practical value, minimizing maintenance cost. As to their musical qualities, Steere Organs are admitted by experts to have more characteristic tones, a finer balance and ensemble, and more perfect diapasons—combining in the deep, round, churchly tone characteristic of English cathedral organs.

The Auditorium in the Springfield, Mass., Municipal Group of Buildings, shown above, is equipped with a Steere Organ.



Two notable Steere Organs—to the left, Church of the Ascension, New York. Below, Bailey Hall, Cornell University, Ithaca, N. Y.

The organ is a part of the church—not an afterthought. It should be incorporated in the original idea—not hastily decided upon at a later date. The drafting of organ specifications is an art in which we have specialized for many years. We offer our service and co-operation to architects, freely.



J.W. Steere & Son
Organ Co.
Springfield, Mass.
Established, 1867

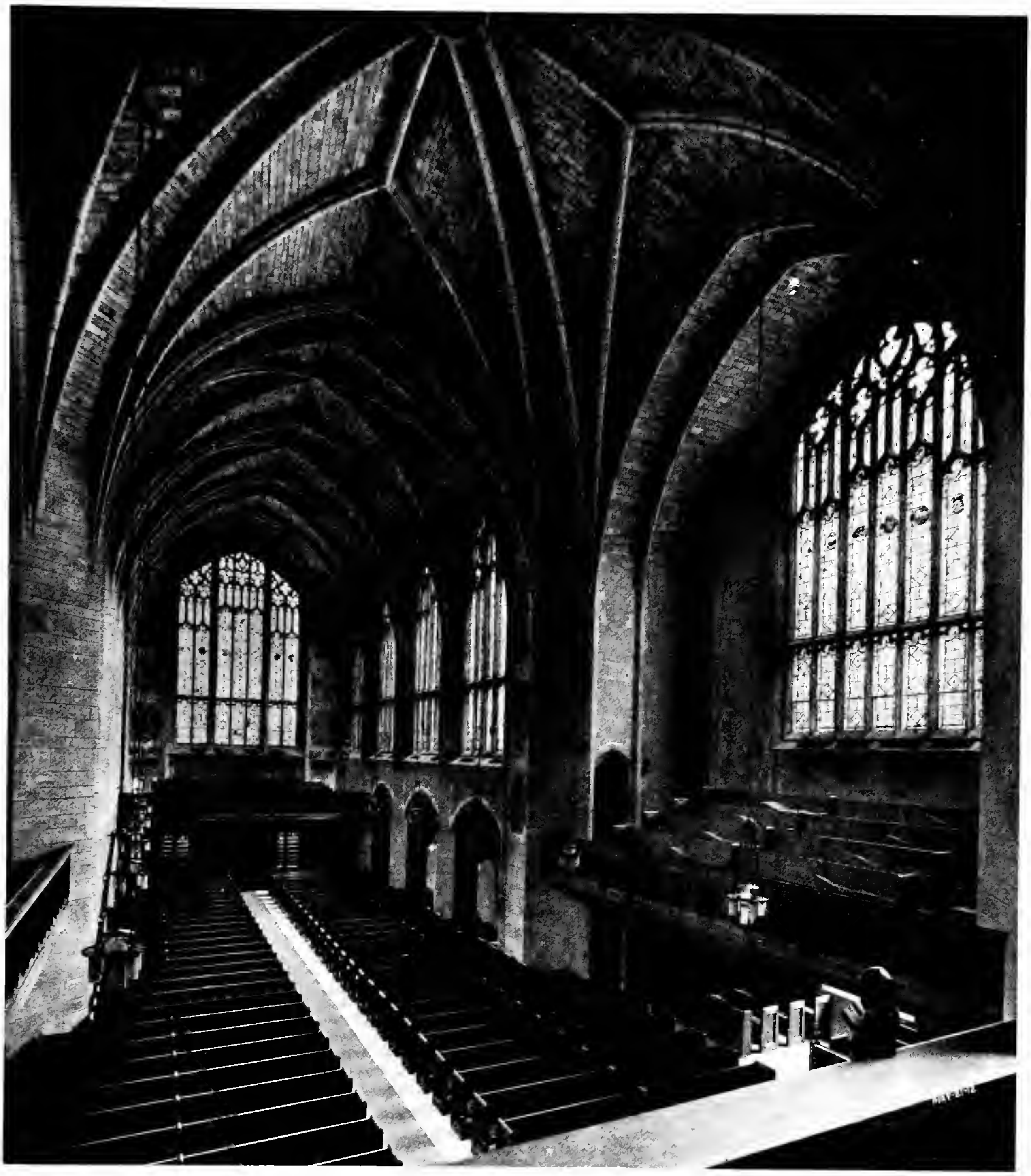
ORGAN IN ST. JAMES'S PROTESTANT EPISCOPAL CHURCH, PHILADELPHIA, PA.

Four Manuals. Fifty-eight Speaking Stops. Organ divided. Great, Choir and part of Pedal on one side of Chancel; Swell, Solo, and part of Pedal on opposite side. Electric action. Movable Keydesk.

Built by

HUTCHINGS ORGAN COMPANY, 18 Tremont St., Boston, Mass.

Factory: Waltham, Mass. New York Office: 156 5th Avenue.



Interior, First Baptist Church, Pittsburgh. Cram, Goodhue & Ferguson, Architects

Ecclesiastical Furniture

PEWS	CONFESSIONALS
ALTARS	VESTMENT CASES
ALTAR RAILS	PULPITS
SCREENS	FONTS

To this work we bring a mastery of the art growing out of forty-four years of experience. The products of our shop are original, dignified, and distinctive. Our execution from architects' designs is characterized by a felicity in detail and a careful attention to the treatment which has merited general approval. We ask an opportunity to submit our ideas, and to place our experience at the architect's service.

Notable examples of our work are found in most of the churches designed by John William Donohue, Maginnis and Walsh, and by Matthew Sullivan, Architects.

Thomas and Company, Inc.

110 Exchange Street
Worcester, Mass.

Beautiful Church Windows, Figure Memorials, in English or German Antique or American Opalescent at prices within the reach of every church.

✠ ✠ ✠

Memorial Tablets in Mosaic Glass, Old Bronze or Illuminated Brass.

✠ ✠ ✠

Lighting Fixtures of the better kind, especially the Semi-Indirect type.

✠ ✠ ✠

Church Decorating in harmony with the architecture in oils or water color, from special designs.

✠ ✠ ✠

Church Silver, Communion Services of every kind as well as Crosses, Vases, Candlesticks and Lecterns.

✠ ✠ ✠

Church Bells, Altars, Benches, and in fact everything that lights and beautifies.

ASKINS ART STUDIOS

Corner Court and
Cortland Streets
Rochester, N. Y.

Established 21 years.

Send all data for designs and estimates which will be cheerfully forwarded.